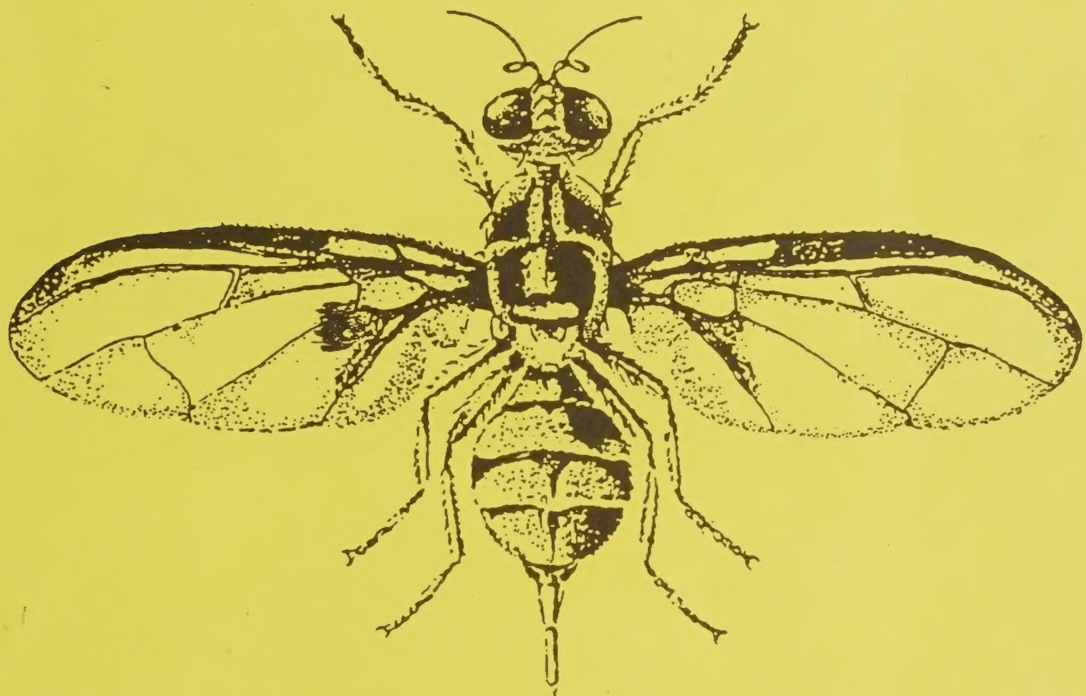
Oriental Fruit Fly Regulatory Program

Environmental Assessment
November 1991



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Executive Summary

The oriental fruit fly, *Bactrocera dorsalis* (Hendel), is a destructive agricultural pest in many parts of the world. The United States Department of Agriculture (USDA), Animal and Plant Health Inspection Service (APHIS), in cooperation with state agriculture departments, has established the Oriental Fruit Fly Regulatory Program to prevent the spread of oriental fruit fly. The program establishes quarantine areas, designates regulated articles (host materials capable of harboring the oriental fruit fly), and requires various treatments as a means for certifying or permitting movement of the regulated articles. Actions taken in the Regulatory Program are under the authority of the Plant Quarantine Act of 1967 (7 United States Code (U.S.C.) 164) and the Federal Plant Pest Act of 1957 (7 U.S.C. 150). The Regulatory Program is separate from any concurrent oriental fruit fly eradication programs, which are under the jurisdiction of individual states.

APHIS analyzed three potential program alternatives for the Oriental Fruit Fly Regulatory Program: (1) no action, (2) quarantine only, and (3) quarantine and commodity certification (the preferred alternative). Control alternatives analyzed included: (1) no action, (2) quarantine only, (3) regulatory chemicals (fumigation, soil treatment, and bait spray application), (4) cold treatment, and (5) vapor heat treatment.

The environmental consequences of the program were comprehensively analyzed. APHIS considered the potential effects of the program's alternative treatment methods on the human environment. Cold treatment and vapor heat treatment pose little threat to the environment and were not considered in detail. The regulatory chemical treatments—methyl bromide fumigation, diazinon soil treatment, and malathion bait applications—were considered in comprehensive detail. They were considered with respect to their potential effects on human health, nontarget organisms, endangered and threatened species, cumulative impacts, and unavoidable environmental effects. Program mitigative measures were detailed, including general measures, chemical applications, aerial applications, and ground applications.

In conclusion, an effectively managed regulatory program is necessary to prevent the spread and subsequent establishment of the oriental fruit fly. APHIS has analyzed fully the potential environmental consequences of the program and concludes that the program will have beneficial effects on the agricultural economy and production of the United States. The program design, the directed nature of program treatments, and specific mitigative measures all serve to minimize or negate potential environmental effects to humans and their environment.

I. Purpose and Need for Proposed Action

A. Introduction

1. General

The oriental fruit fly, *Bactrocera dorsalis* (Hendel) (Synonym = *Dacus dorsalis* Hendel), is a destructive pest of a wide variety of fruits, nuts, vegetables, and berries in many parts of the world. The oriental fruit fly has been established since 1948 in Hawaii where it damages every commercial fruit crop grown there (Drew et al., 1978). Eradication programs have prevented the establishment of the oriental fruit fly a number of times since its first introduction in 1960 to the conterminous United States. Substantial losses to the United States' agricultural industry can be expected if the oriental fruit fly becomes established in the conterminous United States. The species' short life cycle allows rapid population growth, increasing the likelihood of establishment if no action is taken. A prompt response to the detection of oriental fruit fly is required to prevent the spread of the infestation.

The United States Department of Agriculture (USDA), Animal and Plant Health Inspection Service (APHIS), in cooperation with state agriculture departments, has established a Regulatory Program to prevent the spread of oriental fruit fly. The Regulatory Program involves the establishment of quarantine areas from which the movement of regulated articles is restricted. Certificates or limited permits are required to transport regulated articles from the quarantine area. The Regulatory Program is designed to abate the transportation of oriental fruit fly eggs, larvae, pupae, or adults into areas where they have not been detected. The Regulatory Program is separate from any concurrent oriental fruit fly eradication programs, which are under the jurisdiction of individual states.

This environmental assessment analyzes potential environmental effects of the Regulatory Program for the oriental fruit fly and is prepared in accordance with the requirements of the National Environmental Policy Act of 1969 (NEPA).

2. Pest Status and Significance

a. Biology and Origin

The oriental fruit fly is native to Asia and is distributed throughout southeastern Asia, northward to southern China, and is established on many Western Pacific islands.

The oriental fruit fly belongs to the fruit fly family tephritidae, which includes several other species which are pests of agriculture, such as the Mediterranean fruit fly, the Mexican fruit fly, and the melon fly.

The adult oriental fruit fly is slightly larger than the typical housefly. The female has a long slender ovipositor which is used to insert eggs beneath the skin of host fruits. A female may produce over 1,000 eggs during her lifetime; thus, a single mated female can be a serious threat to agriculture. Many females can lay eggs in the same fruit; however, once the eggs hatch

and larvae begin to develop, no more eggs are laid (Fletcher, 1989a). Larval overcrowding can reduce the size and reproductive ability of the adults which develop—an important consequence if host material is limited.

The larvae develop inside the host fruit and tunnel through the fruit feeding on the pulp until they have completed two developmental stages. Next, they emerge from small exit holes in the fruit. The mobile larvae drop from the fruit to the ground, where they burrow into the soil surface to pupate. The larvae can move up to 3 ft along the ground surface before digging burrows into the soil and turning into pupae within the last larval skins (puparia).

The adult flies emerge from the puparia and, under optimal conditions, dig their way out of the soil after about 10 to 12 days. Adult flies feed on honeydew, decaying fruit, plant nectar, bird dung, and ripe fruits. Both the developmental time of the immature stages and the lifespan of the adult fly are influenced by temperature. In warm weather, the lifespan of the adult ranges from 1 to 3 months, while in cooler temperatures adults have been known to live up to 12 months (California Department of Food and Agriculture (CDFA), 1984). During unfavorable weather conditions, the adults aggregate in sheltered refuges and become sexually inactive (Fletcher, 1989b). Sexual activity resumes when weather conditions become favorable.

Following emergence, the immature flies disperse from the area. The newly emerged flies disperse farther if there are few potential host fruits available (Fletcher, 1989b). Adults become sexually mature within 6 to 10 days after emergence if climatic conditions are optimal (CDFA, 1984). Once the flies become sexually mature, their dispersal is directly related to the distribution of host fruit (Fletcher, 1989b). The mobility of the species can decrease its reproductive success by reducing population densities to the point where it is difficult for individuals to find a mate (Fletcher, 1985).

b. Distribution and Spread

The worldwide distribution of oriental fruit fly includes most of Southeast Asia and nearby islands of Indonesia, Micronesia, the Philippines, Sri Lanka, and Taiwan (Drew et al., 1978). The oriental fruit fly is also found in the Hawaiian Islands where it was introduced accidentally and subsequently has become established. Oriental fruit fly infestation occurred in the Marianas and Ryukyus, but was eradicated in 1988. The potential distribution of oriental fruit fly is limited by the climate, distribution of appropriate hosts, and availability of avenues of introduction.

Climatic conditions in the southern conterminous United States would allow the oriental fruit fly to develop from egg to adult stages, and would allow the pest to overwinter. The oriental fruit fly can adapt to arid and subtropical climates, in addition to the tropical conditions that characterize much of its worldwide distribution (Harris, 1989). The climate of many of the southern States could support breeding populations of the fruit fly.

Oriental fruit flies infest a diverse range of hosts which fruit at different times. It is likely that wild and cultivated host fruits would be available

throughout much of the year in some parts of the conterminous United States, such as California or Florida. To become established in a new location, the fly could be transported there as either an egg, larva, pupa, or adult. Natural dispersal of the oriental fruit fly is mainly by adult flight; adults can travel up to 31 mi (Ito and Iwahashashi, 1974, as cited in CDFA, 1984). The fly could be dispersed a much greater distance by humans in the course of travel and through shipment of infested fruits or nursery stock.

c. Host Information

The larvae of the oriental fruit fly have been recorded worldwide in 239 different fruits (USDA, 1989) (see also table IV-1, p. 22-24). Host fruits differ in their susceptibility to infestation by oriental fruit flies (CDFA, 1984). Some hosts that are ordinarily subject to heavy infestation are not suitable for the optimal development of the larvae. The ideal host has been described as a mature ripened succulent fruit with a moderately thick epidermis (CDFA, 1984). Damage to the host is caused by the feeding larvae, which destroy the interior of the fruit. Both sterile and fertile females create oviposition wounds which cause cosmetic damage and reduce the value of the fruit. Bacteria may enter the fruit through the oviposition wound and larval exit holes, thereby further damaging the fruit. Under heavy population pressure, females have oviposited eggs in plant stems which are subsequently damaged by larval feeding (CDFA, 1984).

3. History of the Eradication Effort

All known infestations of the oriental fruit fly in the conterminous United States have occurred in California. Between 1960 and 1991, eight oriental fruit fly introductions were classified as infestations. The oriental fruit fly was successfully eradicated following each infestation. Both adults and larvae were detected for the first time in the conterminous United States during an outbreak in 1974.

4. Current Status of Research for Control

Standard means of applying pesticides have been shown to be ineffective against the oriental fruit fly because the fly normally rests on the underside of leaves, an area which would be sheltered from pesticide sprays (CDFA, 1984). Carefully managed chemical control has been the principal method for eradication of oriental fruit fly. Bait sprays, consisting of a mixture of malathion and a protein hydrolysate, were successfully used to suppress the oriental fruit fly in Guam in 1963-65 and in the Ogasawara Islands in Japan (Gilmore, 1986). Experiments using commercially available pesticides indicate that the insecticide naled kills oriental fruit flies more quickly than malathion, but malathion has a greater residual effectiveness (CDFA, 1984).

Male annihilation has proven to be an effective eradication technique for the oriental fruit fly (Cunningham, 1989). This technique uses a mixture of methyl eugenol, a male attractant, and naled to attract and eliminate the male fruit flies from the population, making it impossible for the female flies to find mates and reproduce (Gilmore, 1986). This technique does not require widespread use of pesticides. In California, a thickened formulation

of methyl eugenol and naled sprayed on poles has proven to be an effective control technique.

A number of parasites, predators, and pathogens have been tested for their ability to control oriental fruit fly. Following the establishment of the oriental fruit fly in Hawaii, 24 different types of predators and parasites were introduced. Only one of these biological control agents, *Biosteres arisanus* (Synonym = *Diachasmimorpha arisanus*), a parasitic wasp, was proven to be effective (CDFA, 1984). Use of this agent alone was inadequate for eradication or control of the oriental fruit fly (CDFA, 1984). Research is currently being conducted in Hawaii using another parasitic wasp, *Biosteres longicaudatus* (Synonym = *Diachasmimorpha longicaudatus)*; however, this technique has not been field tested (Gilmore, 1986). Current research suggests that predators of the oriental fruit fly larvae will not be an effective mechanism for suppression or eradication. Several microbial pathogens have been isolated from oriental fruit fly eggs, but have been ineffective against healthy eggs from oriental fruit flies. No effective microbial pathogens have been identified for oriental fruit fly control (CDFA, 1984).

The release of sterile oriental fruit flies reduces the reproduction of wild populations of the fly. Genetic sexing has been used experimentally to produce predominantly male populations of sterile flies to reduce the damage to host fruits from ovipositioning females. This is not an effective eradication technique when used by itself; it is more effective when combined with another technique that reduces the wild population (CDFA, 1984).

Research is being conducted on increasing host resistance to the oriental fruit fly (Fletcher, 1989). This effort includes genetic engineering to increase a plant's physical and chemical defenses against oriental fruit fly attack. Genetic engineering may also be successful in eliminating from host fruits those species of bacteria normally found associated with oriental fruit flies (Greany, 1989). These bacteria may be critical to the fly in detoxifying the host's chemical defenses or increasing the nutritional value of the host.

B. Need for Program Action

1. Economic Significance

It is estimated that the oriental fruit fly causes substantial agricultural losses in the State of Hawaii where damage from oriental, melon, and Mediterranean fruit flies was estimated at $1.5 million in 1976. Of these three species, the oriental fruit fly was considered to be the most destructive (USDA, 1985). If the oriental fruit fly were to become established in California, the potential losses to the State's agriculture industry were calculated to be $205,474,000 in 1984, with an additional $22,469,000 to $155,618,000 to be spent on more pesticide sprays (CDFA, 1984).

Another loss associated with establishment of the oriental fruit fly would be the cost associated with construction of large-scale treatment facilities to treat fruit before shipment to uninfested areas. Construction of these facilities in California was estimated to be $20,847,000 in 1984, with an annual maintenance cost of $22,156,000 (CDFA, 1984). If the oriental fruit fly were

to become established in California, widespread infestations would likely occur annually, with the annual cost, in 1984 dollars, between $250,099,000 to $343,248,000 (CDFA, 1984). Losses to the United States economy were assessed in 1989 to be $821 to $831 million annually if the Mediterranean fruit fly, a fruit fly with similar hosts and biology, were to become established throughout its potential range (USDA, 1989b).

2. Background and Scope of Proposed Regulatory Action

USDA has established a Regulatory Program involving quarantines to prevent the interstate spread of oriental fruit fly. USDA has employed this Regulatory Program in past infestations of oriental fruit fly in California. The Regulatory Program utilizes some control measures to prevent the spread of the pest, but does not include control measures associated with eradication or suppression of the oriental fruit fly.

3. Statutory Authority

USDA is empowered to establish quarantine areas under the Plant Quarantine Act of 1967 (7 United States Code (U.S.C.) 164) , which regulates the importation of nursery stock, plants, and plant products and establishes quarantine districts to regulate the movement of fruits, vegetables, and plants for other purposes such as interstate shipments. The Federal Plant Pest Act of 1957 (7 U.S.C. 150) enables USDA to use emergency measures set up by the Secretary. Inspections and seizures of regulated articles are authorized under this act. The Domestic Quarantine Notices, Subpart Oriental Fruit Fly (7 Code of Federal Regulations (CFR) 301.93) sets forth the Agency regulations to be followed for oriental fruit fly infestations.

4. Regulatory Program Goal

The goal of the Regulatory Program is to prevent the oriental fruit fly from spreading into areas where it does not exist. Preventing the spread of the oriental fruit fly will also decrease future costs associated with eradicating or suppression efforts in areas where it is not currently established.

II. Program Alternatives

A. No Action

Under the no action alternative, there would be no Federal effort to quarantine and contain any outbreak or infestation of introduced oriental fruit fly. Movement of infested commodities from the areas of introduction would occur without Federal regulations. This would place the control efforts on the growers and state and local governments. If the efforts of state and local governments were unsuccessful at eradicating (or at least containing the infestation), additional applications of insecticides might be needed by growers to maintain oriental fruit fly below economic thresholds. The oriental fruit fly could eventually become distributed over its maximum potential range in the conterminous United States. Foreign markets for United States produce could decide not to accept the produce rather than risk infestation by oriental fruit fly. A market loss of this type could be substantial.

Potential advantages associated with this alternative include: (1) the redirection of oriental fruit fly program funding to other necessary programs; (2) relocation or reassignment of program personnel to other programs; (3) freedom from domestic oriental fruit fly regulatory constraints, and (4) the opening of U.S. mainland markets in infested areas to foreign imports from oriental fruit fly-infested countries.

Potential disadvantages associated with this alternative include: (1) increased outbreaks and the opportunity for establishment of oriental fruit fly in the United States; (2) increased crop losses for the United States; (3) potential loss of agricultural export markets to some foreign countries; (4) loss of employment for some citizens; (5) increased eradication and suppression efforts; (6) increased and uncoordinated commercial use of pesticides to control oriental fruit fly, with associated potentially adverse environmental impacts; (7) reduced cooperation among Federal, state, and local governments in pest management; and (8) loss of interagency research efforts to develop more effective control, containment, and eradication of oriental fruit fly (e.g., USDA, Agricultural Research Service efforts).

B. Quarantine Only

Under the quarantine-only alternative, the Federal action would be to restrict regulated commodities harvested within the quarantine area to movement within that area. Restricted movement of commodities would reduce the spread of oriental fruit fly to new areas, but would result in an infestation remaining established within the quarantine boundaries. The efforts of state and local governments to eradicate the oriental fruit fly from these areas would be less effective if no control effort were employed for such a situation. The Federal quarantine requires that the commodities harvested within the quarantine boundaries be destroyed or their sale limited to the local retail market within the quarantined area. In widespread or heavy

infestations, activities such as safeguarding of local fruit stands, mandatory baggage inspection at airports, and judicious use of road patrols and roadblocks may be necessary to contain the infestation.

Potential advantages associated with this alternative include: (1) no supervision of quarantine treatments for commodity certification; (2) elimination of any potential adverse effects from use of chemical controls in Federal actions; (3) prevention of the potential spread of oriental fruit fly by restricting the movement of harvested produce from host crops; (4) containment of the infestation during each fruit fly generation to only the potential flight distance of flies from the core area (4½-mi area around the oriental fruit fly detection site) or detected areas; and (5) maintenance of some interagency research efforts to develop more effective controls, containment, and eradication of the oriental fruit fly.

Potential disadvantages associated with this alternative include: (1) loss of domestic markets for produce resulting in profit loss; (2) potential for oriental fruit fly establishment within the quarantine area; (3) increased commercial use of pesticides in an uncoordinated manner within the quarantined area, with accompanying potential adverse environmental impacts; (4) potential loss of agricultural export markets and adverse impacts to exporters; (5) minor local loss of employment; (6) increased potential for spread of oriental fruit fly by flight from infested areas due to limited intervention in agricultural areas; and (7) lack of a sufficient workforce to effectively enforce such a quarantine.

C. Quarantine and Commodity Certification (Preferred Alternative)

This alternative couples the Federal quarantine previously described with commodity treatment and certification. The Plant Protection and Quarantine commodity certification regulations set requirements for the movement of regulated produce harvested within the quarantined boundaries to locations outside this restricted area. The interstate movement of this produce requires the issuance of a certificate or limited permit (7 CFR Part 301; August 21, 1989). The issuance of a certificate or limited permit is contingent on the grower or shipper complying with specific conditions that are designed to minimize pest risk and prevent spread of the oriental fruit fly. The required conditions are stipulated to verify that the produce harvested for market is free of oriental fruit fly life stages. These conditions are met through confirmation of certain regulatory chemical control treatments. These treatments are described in detail in section III., Control Alternatives, in this document (see p. 11-19).

Potential advantages associated with this alternative include: (1) prevention of the spread and resultant establishment of the oriental fruit fly in host crop areas; (2) capability of local growers within quarantined areas to sell their produce locally and in the larger United States market; (3) acceptance of certified produce by agricultural export markets in many foreign countries; (4) no loss of employment for agricultural workers in the

quarantined area; (5) less need for eradication and suppression efforts; (6) coordinated and controlled use of pesticides to prevent unnecessary treatments and associated potential adverse environmental effects; (7) continued cooperation among Federal, state, and local governments in eradication efforts for oriental fruit fly; and (8) continued strong support for interagency research efforts designed to develop more effective control, containment, and eradication of oriental fruit fly.

Potential disadvantages associated with this alternative include: (1) potential expansion of the quarantined area if efforts of state and local government are inadequate to contain or eradicate the oriental fruit fly infestation; (2) potential loss of some foreign export markets for produce from quarantined areas due to other countries' unwillingness to accept the produce certification; and (3) increased Federal involvement and cost for quarantines and commodity certification of produce within the quarantine boundaries.

III. Control Alternatives

A. No Action

The no action alternative would involve no regulatory effort to restrict spread of the oriental fruit fly or facilitate movement of oriental fruit fly host materials and other regulated articles. In the absence of Federal regulatory controls, the control efforts by government to contain, suppress or eradicate the fly would be limited to state and local attempts. It is likely that individual farmers and grower groups would also have to apply chemical controls to maintain crop damage below the economic threshold if the oriental fruit flies were not contained. The spread of the oriental fruit fly would then be limited only by the proximity of host plants and climatic conditions. Expansion of the range of the oriental fruit fly in this manner would result in significant economic losses to the growers in the United States as well as loss of some agricultural markets.

Each year, oriental fruit fly host produce is illegally brought into the United States from other countries or from areas of Hawaii where the fly is established. These illegal movements of produce can lead and probably have led to isolated outbreaks or infestations of oriental fruit fly in the conterminous United States. The economic cost of eradicating such outbreaks can range into millions of dollars. The no action control alternative is basically the same as the no action program alternative previously discussed in this environmental assessment.

B. Quarantine Only

Under the quarantine-only control alternative, the Federal action would be to restrict regulated commodities harvested within the quarantine area to movement only within the quarantine area. This control alternative is basically the same as the quarantine-only program alternative discussed previously in section II.B. (p. 7-8) wherein it describes the benefits and limitations of the quarantine-only program. This section will focus on specific operational and nonchemical aspects of a regulatory quarantine-only action.

Upon detection of an infestation, all growers and establishments that grow, handle, or process regulated articles within 4½ mi of the epicenter (detection site) of the infestation are issued Emergency Action Notifications. If necessary, the Deputy Administrator, Plant Protection and Quarantine, APHIS, may direct the field officers to initiate specific emergency action under the Federal Plant Pest Act (7 U.S.C. 150dd) until Federal regulations can be published in the Federal Register. State and local cooperators will be informed of the detection, actions contemplated, and actions taken. Other information about procedural aspects is provided in the USDA, APHIS Action Plan for Oriental Fruit Fly (1989).

Regulatory quarantines are required from the time an oriental fruit fly infestation is detected until all flies are eradicated from the regulated area. These quarantines restrict the movement of certain articles produced or grown in the quarantined area. The regulated articles include known hosts of the oriental fruit fly, cannery waste, soil within the drip line of host plants, and any other product, article, or means of conveyance determined by an inspector to pose a risk of oriental fruit fly spread. There are 239 host plants of this pest, including many citrus, stone, and pome fruits, and nuts, berries, and vegetables. An updated list of regulated host plants is provided in table III-1 (see p. 13-15) of this environmental assessment. These hosts have been determined to present the greatest risk of oriental fruit fly spread in the conterminous United States.

The principal activities necessary for conducting a regulatory program are dependent upon the degree of infestation. For example, safeguarding local retail fruit stands throughout the entire regulated area may not be necessary if the quarantine is established based on a very localized, light infestation. On the other hand, mandatory checks of passenger baggage at airports, judicious use of road patrols, and roadblocks to monitor quarantine compliance may be necessary to contain general or heavy infestations. Regulatory actions may also be required at properties of local growers, packing houses, landfills, freight companies, post offices, flea markets, produce markets, farmers' markets, transportation depots, canneries, and produce processing establishments. Adequate disposal of regulated articles at landfills to eliminate pest risk may be particularly important. Records are maintained for each regulatory action taken in compliance with the promulgated quarantine regulations.

C. Regulatory Chemicals

The interstate movement of certain regulated commodities originating in areas quarantined because of oriental fruit fly infestations requires the issuance of a certificate or limited permit (7 CFR Part 301.93). The issuance of a certificate or limited permit is contingent on grower or shipper compliance with certain conditions designed to prevent spread of the oriental fruit fly out of the quarantined area. The conditions of certificates and limited permits may require treatment of the harvested commodity or premises in the field. Another option may be fumigation of the harvested commodity at a location within the quarantined area before its movement. It is the intent of APHIS to facilitate the movement of agricultural commodities from the quarantined areas without posing any risk of spread of viable oriental fruit fly life stages to uninfested areas. The use of required regulatory chemical treatment serves to allow this movement for specific commodities.

Although only certain treatments are approved for certification that produce is free of oriental fruit fly, USDA's Agricultural Research Service in Hawaii is researching to find more efficacious and species-specific regulatory and eradication techniques. The Regulatory Program relies only on those chemicals registered with EPA for certification purposes and which have proven to

Table III-1. Regulated Articles in Quarantine Area

Common name	Scientific name
Akia	*Wikstroemia phyllyraefolia*
Almond:	
Myrobalan	*Terminalia chebula*
Tropical	*Terminalia catappa*
Apple:	
Common	*Malus domestica*
Malay	*Syzygium malaccense*
Otaheite	*Spondias cytherea*
Apricot	*Prunus armeniaca*
Avocado	*Persea americana var. americana*
Banana:	
Common	*Musa paradisiaca* var. *paradisiaca*
Dwarf	*Musa acuminata*
Breadfruit	*Artocarpus altilis*
Cactus, saguaro	*Cereus coerulescens*
Caimitillo (satin leaf)	*Chrysophyllum oliviforme*
Calamondin	*Citrofortunella mitis*
Cashew	*Anacardium occidentale*
Cherimoya	*Annona cherimola*
Cherry:	
Barabados	*Malphighia punicifolia*
Brazilian	*Eugenia dombeyi*
Jerusalem	*Solanum psuedocapsicum*
Portuguese	*Prunus lusitania*
Spanish	*Mimusops elengi*
Surinam	*Eugenia uniflora*
Coffee, arabica	*Coffea arabica*
Cucumber	*Cucumis sativus*
Custard-apple	*Annona reticulata*
Dragon tree	*Dracaena draco*
Egg-fruit tree	*Pouteria campechiana*
Fig, common	*Ficus carica*
Gooseberry, Ceylon	*Dovyalis hebecarpa*
Gourka	*Garcinia celbia*
Granadilla, sweet	*Passiflora ligularis*
Grape	*Vitis* spp.
Grapefruit	*Citrus paradisi*
Guava:	
Common	*Psidium guajava*
Strawberry	*Psidium cattleianum*
Yellow strawberry	*Psidium cattleianum* var. *littorale*
Imbu	*Spondias tuberosa*
Jackfruit	*Artocarpus heterophyllus*
Kumquat, round	*Fortunella japonica*
Laurel, Indian	*Calophyllum inophyllum*

continued

Table III-1., continued

Common name	Scientific name
Lemon	*Citrus limon*
Lime, key	*Citrus aurantiifolia*
Longan	*Dimocarpus longan*
Loquat	*Eriobotrya japonica*
Lychee	*Lichi chinensis*
Mammee-apple	*Mammea americana*
Mango	*Mangifera indica*
Mangosteen	*Garcinia mangostana*
Mulberry, black	*Morus nigra*
Myrtle, downy	*Rhodomyrtus tomentosa*
Nectarine	*Prunus persica* var. *nectarina*
Nightshade	*Solanum* spp.
Oleander, yellow	*Thevetia peruviana*
Orange:	
Jasmine	*Murraya paniculata*
King	*Citrus nobilis*
Sour	*Citrus aurantium*
Sweet	*Citrus sinensis*
Unshu	*Citrus nobilis unshu*
Palm:	
Coquito	*Jubaea spectabilis*
Date	*Phoenix dactylifera*
Papaya, common	*Carica papaya*
Passion-flower maypop	*Passiflora incarnata*
Passion fruit	*Passiflora edulis* var. *flavicarpa*
Passion fruit, banana	*Passiflora mollissima*
Peach	*Prunus persica*
Pear, common	*Pyrus communis*
Pepino	*Solanum muricatum*
Pepper:	
Bell	*Capsicum annum* var. *annum*
Chili	*Capsicum frutescens* var. *longum*
Oriental bush red	*Capsicum frutescens* var. *abbreviatum*
Sweet	*Capsicum frutescens* var. *grossum*
Persimmon, Japanese	*Diosypros kaki*
Plum:	
American	*Prunus americana*
Natal	*Carissa macrocarpa*
Pomegranate	*Punica granatum*
Prune, common	*Prunus domestica*
Pummelo	*Citrus maxima*
Quince	*Cydonia oblonga*
Rose-apple	*Eugenia jambos*

continued

Table III-1., continued

Common name	Scientific name
Sandalwood:	
Red	*Pterocarpus sanatalinus*
White	*Santalum album*
Santol	*Sandoricum koetjape*
Sapodilla	*Manilkara zapota*
Sapote, white	*Casimiroa edulis*
Seagrape	*Coccoloba uvifera*
Star-apple	*Chrysophyllum cainito*
Starfruit	*Averrhoa carambola*
Tangerine	*Citrus reticulata*
Tomato	*Lycopersicon esculentum*
Walnut	
California	*Juglans californica*
English	*Juglans regia*
Wampi	*Clausena lansium*
Ylang-Ylang	*Cananga odorata*

be effective in eliminating the oriental fruit fly. Future research may provide data to support additional chemical treatments that meet these criteria.

APHIS' Administrator determines acceptance of these treatments for program regulatory controls after reviewing the efficacy, environmental analyses, and documentation.

This section describes the chemical treatments required to certify movement of regulated agricultural commodities out of the quarantine area. The USDA, APHIS, Plant Protection and Quarantine Treatment Manual provides further details of treatment procedures. This manual, which is periodically revised to provide the current recommendations, is incorporated by reference in the Oriental Fruit Fly Regulatory Program Environmental Assessment. In the event of an oriental fruit fly introduction and subsequent quarantine action by the USDA, a Federal Register notice is issued and the quarantine is published in 7 CFR 301.93; these issuances also list regulatory treatments and are incorporated by reference.

1. Fumigation

Fumigation of a regulated commodity with methyl bromide is one available option for allowing the movement of commodities harvested within the quarantined area. Methyl bromide is a broad spectrum pesticide commonly applied as a fumigant for insects, nematodes, fungi, rodents, and selected plants and seeds. In addition to its good efficacy, methyl bromide also has the advantages of: rapid dissipation following treatment and proper aeration, nonflammable and nonexplosive characteristics, and stability in gaseous form to relatively low temperatures (down to 4°C). This treatment may also be combined with approved cold treatment (discussed in section III.D., see p. 18) to fulfill requirements for certifying that some commodities are free of oriental fruit fly.

The fumigations with methyl bromide must be done within the quarantine area. All fumigations are conducted according to the pesticide label and comply with all Federal, state, and local regulations. The amounts and concentrations of methyl bromide and the duration of the fumigation are dependent upon the air temperature, the commodity being fumigated, the adsorptive and absorptive properties of the fumigation enclosure and contents, and the presence of any materials that present fumigant penetration problems. Fumigation procedures required for certified treatment of specific commodities are given in the Plant Protection and Quarantine Treatment Manual in sections T102 and T105 through T108. The regulatory fumigations for oriental fruit fly require up to 4 hours of treatment at 32 g/m^3 at or above 70°F (21°C) or up to 48 g/m^3 for 2 hours at the same temperatures.

The fumigations required for movement of the regulated commodities are supervised by an APHIS representative. The fumigation enclosure consists of a tarpaulin or a more permanent chamber with an impervious surface on which the commodity is placed. The base of the enclosure is secured by sandbags to prevent gas leakage. A fumiscope measures the methyl bromide concentration in the fumigation chamber. A drip shield is placed at the

outlet nozzle to collect any liquid fumigant and protect the harvested commodity from potential damage due to chemical burns. All personnel entering an area within 30 ft of the fumigation enclosure are required to wear self-contained breathing apparatus to ensure personal safety. Hazard warning signs are posted at all entrances to the controlled fumigation area. A halide detector is used to check for leaks around the fumigation enclosure. Fans are placed inside the fumigation enclosure to maintain even distribution of methyl bromide throughout the enclosure. Aeration is conducted after treatment until the fumiscope indicates that no methyl bromide is present. Before opening the fumigation enclosure to remove the treated commodity, a reading is taken at the enclosure entrance using a draeger tube (color indicator tube) to verify that methyl bromide concentrations are below the threshold limit value in the air.

A disadvantage to using methyl bromide is the possibility of accidental human exposure because of its odorless and colorless properties. Inhalation of methyl bromide at standard fumigation concentrations can result in toxic effects. Potential exposure can be prevented by following the safety procedures required for all program fumigations.

2. Soil Treatment

Soil treatments are applied as drench applications to an area within the drip line of the host plants using ground spray equipment. The treatment consists of the insecticide, diazinon, applied at the rate of 5 lb of active ingredient (a.i.) per sprayed acre and diluted with sufficient water to wet the soil to at least a depth of ½ in. Applications are limited to nursery stock growing within the quarantine areas that produce regulated commodities. This treatment is restricted to one application within the drip line of host plants unless reinfestation occurs.

Regulatory certification achieved by soil treatments provides for movement of regulated nursery stock out of the quarantine area, but only if the nursery stock has been stripped of fruit. The soil treatment is done just prior to shipping and is designed to eliminate the potential movement of any viable oriental fruit fly larvae or pupae. The soil treatment effectively eliminates pest risk from the soil and, combined with the removal of fruit, assures that the nursery stock and soil will remain free of oriental fruit fly.

3. Bait Spray Application

Malathion bait spray is a mixture of a toxicant (malathion) and a bait (protein hydrolysate, e.g., Nulure®). The bait acts as an attractant and feeding stimulant to both adult male and female oriental fruit flies (Hagan, 1953). The toxicant, malathion, is an organophosphate insecticide which is highly toxic to oriental fruit fly in laboratory tests (Keiser et al., 1973). Malathion applied as a bait spray is highly effective in attracting and killing populations of oriental fruit fly in the field (Steiner, 1952; Steiner, 1955).

Applications of bait spray in the Regulatory Program are limited to those fields, groves, and areas which produce regulated commodities within the quarantine area, but are located outside the infested core area. Conditions for movement of regulated commodities on those premises require treatment with malathion bait spray at 6- to 10-day intervals, starting a sufficient time

(but not less than 30 days) before harvest to allow completion of egg and larval development and continuing through the harvest period. Time for completing egg and larval development is determined using an oriental fruit fly life cycle model in combination with temperature data. The bait spray is applied by aerial or ground equipment at a rate of 2.4 fl oz of ultra low volume (ULV) malathion (2.8 troy ounces of malathion a.i.) and 9.6 fl oz of protein hydrolysate per acre. The required pre-harvest treatment makes this option useful only for those commodities which will remain in the field for sufficient time after the given area is quarantined for oriental fruit fly.

D. Cold Treatment

Cold treatment is another option for certifying that produce is free of oriental fruit fly. Some commodities are sensitive to methyl bromide fumigation and may require cold treatment. There are also acceptable regulatory treatments which require the use of both fumigation and cold treatments. The acceptable regulatory treatments are commodity specific and are described in detail in the Plant Protection and Quarantine Treatment Manual.

All cold treatments must be conducted in approved facilities under the supervision of an APHIS representative. The facility must be within the quarantine area and cold treatment must be completed before the commodity is moved from the quarantine area. The facility must be secure and must provide adequate refrigeration and thermostatic control to meet the required cold treatment schedules for certification. A minimum of three sensors must monitor temperatures within the cold treatment chamber to assure that there is a uniform cold treatment. The temperature is recorded at least once every hour for each sensor until the treatment is completed. An APHIS representative calibrates and certifies recording instruments and temperature sensors. These instruments and sensors must be accurate to within plus or minus 0.25°F of the true temperature within the range of 27° to 37°F.

The cold treatment is limited to certain approved commodities which are not harmed by the cold temperatures and result in produce free of oriental fruit fly. The cold treatments require 4 to 11 days at or below a given temperature at all times. If this treatment is used in combination with fumigation, the time lapse between fumigation and the start of cooling must not exceed 24 hours. The necessary restrictions on cold treatments for certification are likely to limit the use of this treatment in the Regulatory Program.

E. Vapor Heat Treatment

Vapor heat treatment is another control technique that may be used to certify that produce is free of the oriental fruit fly. These treatments are described in detail in the Plant Protection and Quarantine Treatment Manual.

An APHIS representative must supervise all heat vapor treatments and they must be conducted in an approved facility. The facility must be within the quarantine area and the heat vapor treatment must be completed prior

to the commodity's movement from the quarantine area. The facility must be secure and must provide adequate heating, water vapor, and thermostatic control to meet the required vapor heat treatment schedules for certification. The thermal controls must be able to raise the internal temperature of the commodity to as high as 44.4°C and maintain that temperature for up to 8½ hours before cooling.

This treatment is limited to certain approved commodities which are not harmed by the hot water vapor and result in produce free of oriental fruit fly. This treatment is conducted primarily for tomatoes and peppers. Vapor heat treatment will probably not be used often.

IV. Affected Environment and Environmental Consequences

A. Potential Program Areas

The oriental fruit fly Regulatory Program activities generally will be conducted in conjunction with a state eradication program and will be dependent to a great extent on the commodities regulated. The goal is to eliminate the pest from the regulated commodities and prevent its spread to other locations. All Regulatory Program activities described in this document will be required until the pest is eradicated and will be restricted to defined quarantine area.

The quarantine area is centered around the oriental fruit fly detection area. This area is approximately 81 mi^2; the exact quarantine boundaries will be determined by the extent of the infestation, distribution of host material, and quarantine enforcement considerations. In this area, host fruits, nuts, vegetables, berries, and soil within the drip line of these plants become designated regulated articles, which may not move interstate without certification.

Although the pest could be introduced to many locations because of potential avenues of introduction, pest biology, and climatic conditions, APHIS or State cooperating agencies have various detection programs for oriental fruit fly in Arizona, California, Florida, Louisiana, New Mexico, Puerto Rico, and Texas. The oriental fruit fly is unlikely to be a problem in colder areas of the country. It is difficult to precisely describe all possible program locations, but they may include rural, suburban, and urban areas, and may include markets and airports. Program areas may be near locations where oriental fruit fly host commodities are grown commercially (table IV-1, see p. 22-24).

Properties which grow regulated commodities generally have climates and water regimes (artificial or natural) which are capable of supporting a variety of crops. Because this is a programmatic environmental assessment, it will not be possible to predict and characterize all potential program areas. Site-specific conditions which could influence environmental fate, degradation, uptake, exposure, and other environmental consequences will be considered as each program arises.

Areas growing regulated commodities for commercial use are characteristically monocultures undergoing intensive management. This generally includes a pesticide treatment program conducted by the owner or grower. Often, in rural to semi-rural locations, these properties are largely artificial environments which do not support a great variety of indigenous flora and fauna, particularly endangered or threatened species and critical habitats. Proximity to natural areas such as parks, forests, and wildlife refuges and management areas is of concern, however, and will be considered on a site-specific basis for each program action.

Table IV-1. Plant Hosts of the Oriental Fruit Fly in the Continental United States

Common name	Scientific name
Akia	*Wikstroemia phyllyraefolia*
Almond:	
Myrobalan	*Terminalia chebula*
Tropical	*Terminalia catappa*
Apple:	
Common	*Malus domestica*
Malay	*Syzygium malaccense*
Otaheite	*Spondias cytherea*
Velvet	*Diospyros discolor*
Apricot	*Prunus armeniaca*
Avocado	*Persea americana* var. *americana*
Banana:	
Common	*Musa paradisiaca* var. *paradisiaca*
Dwarf	*Musa acuminata*
Breadfruit	*Artocarpus altilis*
Cactus:	
Saguaro	*Cereus coerulescens*
Spineless	*Opuntia ficus-indica*
Caimitillo (satin leaf)	*Chrysophyllum oliviforme*
Calamondin	*Citrofortunella mitis*
Cashew	*Anacardium occidentale*
Cherimoya	*Annona cherimola*
Cherry:	
Barabados	*Malphighia punicifolia*
Brazilian	*Eugenia dombeyi*
Catalina	*Prunus lyonii*
Hollyleaf	*Prunus ilicifolia*
Jerusalem	*Solanum psuedocapsicum*
Portuguese	*Prunus lusitania*
Spanish	*Mimusops elengi*
Surinam	*Eugenia uniflora*
Coffee, arabica	*Coffea arabica*
Cotton	*Gossypium* spp.
Cucumber	*Cucumis sativus*
Custard-apple	*Annona reticulata*
Dragon tree	*Dracaena draco*
Egg-fruit tree	*Pouteria campechiana*
Fig, common	*Ficus carica*
Gooseberry, Ceylon	*Dovyalis hebecarpa*
Gourka	*Garcinia celbia*
Granadilla:	
Sweet	*Passiflora ligularis*
Yellow	*Passiflora laurifolia*
Grape	*Vitis* spp.

continued

Table IV-1., continued

Common name	Scientific name
Grapefruit	*Citrus paradisi*
Guava:	
Common	*Psidium guajava*
Pineapple	*Feijoa sellowiana*
Strawberry	*Psidium cattleianum*
Yellow strawberry	*Psidium cattleianum* var. *littorale*
Imbu	*Spondias tuberosa*
Jackfruit	*Artocarpus heterophyllus*
Kumquat, round	*Fortunella japonica*
Laurel, Indian	*Calophyllum inophyllum*
Lemon	*Citrus limon*
Lime, key	*Citrus aurantiifolia*
Longan	*Dimocarpus longan*
Loquat	*Eriobotrya japonica*
Lychee	*Lichi chinensis*
Mammee-apple	*Mammea americana*
Mango	*Mangifera indica*
Mangosteen	*Garcinia mangostana*
Mulberry, black	*Morus nigra*
Myrtle, downy	*Rhodomyrtus tomentosa*
Nectarine	*Prunus persica* var. *nectarina*
Nightshade	*Solanum* spp.
Oleander, yellow	*Thevetia peruviana*
Orange:	
Jasmine	*Murraya paniculata*
King	*Citrus nobilis*
Sour	*Citrus aurantium*
Sweet	*Citrus sinensis*
Unshu	*Citrus nobilis unshu*
Palm:	
Date	*Phoenix dactylifera*
Coquito	*Jubaea spectabilis*
Papaya, common	*Carica papaya*
Passion-flower maypop	*Passiflora incarnata*
Passion fruit	*Passiflora edulis* var. *flavicarpa*
Passion fruit, banana	*Passiflora mollissima*
Peach	*Prunus persica*
Pear, common	*Pyrus communis*
Pepino	*Solanum muricatum*
Pepper:	
Bell	*Capsicum annum* var. *annum*
Chili	*Capsicum frutescens* var. *longum*
Oriental bush red	*Capsicum frutescens* var. *abbreviatum*
Sweet	*Capsicum frutescens* var. *grossum*

continued

Table IV-1., continued

Common name	Scientific name
Persimmon, Japanese	*Diosypros kaki*
Plum:	
American	*Prunus americana*
Garden	*Prunus domestica*
Natal	*Carissa macrocarpa*
Pomegranate	*Punica granatum*
Prune, common	*Prunus domestica*
Pummelo	*Citrus maxima*
Quince	*Cydonia oblonga*
Rose-apple	*Eugenia jambos*
Sandalwood:	
Red	*Pterocarpus sanatalinus*
White	*Santalum album*
Santol	*Sandoricum koetjape*
Sapodilla	*Manilkara zapota*
Sapote, white	*Casimiroa edulis*
Seagrape	*Coccoloba uvifera*
Soursop	*Annona muricata*
Star-apple	*Chrysophyllum cainito*
Starfruit	*Averrhoa carambola*
Strawberry	*Fragaria* spp.
Sugar-apple	*Annona squamosa*
Tangerine	*Citrus reticulata*
Tomato	*Lycopersicon esculentum*
Walnut:	
California	*Juglans californica*
English	*Juglans regia*
Wampi	*Clausena lansium*
Ylang-Ylang	*Cananga odorata*

B. Environmental Consequences

1. Physical Environment

a. No Action Alternative

Under the no action alternative, no Federal effort would be made to prevent pest movement; oriental fruit fly quarantine and eradication or control efforts would be left to state and local governments as well as individual growers and applicators. These individuals and organizations will respond in various ways, depending on the range and extent of pest infestation and resultant damage. The net effect of this could be increased pesticide usage with an attendant load to air, water, and soil. These pesticides and/or pattern of use possibly could be harmful to the environment.

If the oriental fruit fly were to become established, repeated applications of pesticides by homeowners in urban areas would likely occur (CDFA, 1984). CDFA estimates that 2.2 to 3.4 million lb a.i. of pesticides would be introduced into the environment annually. Growers could use any available pesticides or combinations of pesticides.

b. Quarantine Only

The quarantine-only regulatory control could deter spread of the pest. Regulated articles could not be moved from the quarantine area; they could only be used within the quarantine area (e.g., processing) or destroyed to prevent pest movement. Commuting time for the public, fuel costs, and additional car exhaust could increase if quarantine stations or roadblocks are established. Potential physical impacts might arise as a consequence of commodity destruction. Air quality could possibly be impacted if commodities were burned; landfill space would be used for waste material. The response by state and local governments or individual growers and applicators could be increased pesticide usage to control or eradicate the pest within the quarantine area.

c. Quarantine and Commodity Certification

The preferred quarantine and commodity certification alternative would result in the least economic loss. However, commuting time for the public, fuel costs, and additional car exhaust could increase if quarantine stations or roadblocks are established. As with the quarantine-only alternative, pesticide use outside the quarantine area would be reduced over the no action alternative.

Cold treatment and vapor heat treatment regulatory control alternatives pose little threat to the environment. The Regulatory Program's chemical treatments—methyl bromide fumigation, diazinon soil treatment, and application of malathion bait spray—will be conducted in conformance with all applicable Federal laws. Pesticide application methods and application rates will be authorized, will follow pesticide labels, and will be conducted in a safe manner. For any treatments not in conformance with current pesticide labels, an emergency exemption will be obtained under the Federal

Insecticide, Fungicide, and Rodenticide Act, Section 18 (emergency exemption) or 24C (special local needs registration).

The pesticides diazinon, malathion, and methyl bromide, used in the Oriental Fruit Fly Regulatory Program's chemical control alternatives are efficacious against several life stages of the target organism. The pesticides are nonspecific however, and potential environmental effects may be anticipated based on environmental fate, toxicity, and potential for exposure. The fate of each pesticide will be considered here; toxicity and exposure will be discussed in following subsections.

The environmental fate of a pesticide is dependent on its chemical and physical characteristics. Factors such as formulation, climate, physical and biological components of water and soil, land management practices, and method and timing of application affect the ultimate destination of a pesticide and its breakdown products. Pesticides may enter the soil profile through direct application or infiltration; the atmosphere through volatilization; surface waters by runoff or in eroded soil; and ground water by leaching. Degradation in these media may be by photolysis, hydrolysis, or biological or chemical means.

All three pesticides, diazinon, malathion, and methyl bromide, are registered for use on several commodities. EPA has established tolerances (maximum concentrations) for residues which can remain on food (40 CFR 180) (see tables IV-2, IV-3, IV-4, and IV-5, p. 27-35). Ingestion of these small amounts of residues is not considered to have any toxicological effect. Tolerances for diazinon range from 0.1 to 0.75 ppm for human foodstuffs (40 CFR 180.153).

(1) Fate of Methyl Bromide

Methyl bromide (CH_3Br) is an odorless, colorless, non-flammable stable gas (boiling point, 4°C) which penetrates rapidly into sorptive materials. Although the gas is three times as heavy as air, it is extremely volatile. After fumigation, vapors quickly dissipate with proper aeration.

Widely used in soil and grain fumigation to control insects, mites, nematodes, and rodents as well as mold and bacteria, methyl bromide has been used for plant quarantine purposes since the 1930's here and in Europe. It was first registered in 1961. Although its mode of action is not well understood, methyl bromide is an alkylating agent, a substance that deactivates enzymes and disrupts nucleic acid synthesis (Ware, 1989) and may attach to protein molecules.

Methyl bromide contains the chemical element bromine which is also found in the atmosphere. The total amount in the atmosphere is small. Aerosols from marine wave action (the oceans average 1.2 ppb bromine) account for approximately 80% of the source of global bromine in the air (Singh et al., 1983) . Combustion and exhaust from internal combustion engines contribute about 10% of the atmospheric bromine and industrial and agricultural

Table IV-2. Diazinon Residue Tolerances in Agricultural Commodities

Commodity	Tolerance (ppm)
Alfalfa, fresh	40.00
Alfalfa, hay	10.00
Almonds	0.50
Almonds, hulls	3.00
Apples	0.50
Apricots	0.50
Bananas, with peel	0.20
Bananas, pulp only	0.10
Beans, forage	25.00
Beans, hay	10.00
Beans, guar	0.10
Beans, guar, forage	0.10
Beans, lima	0.50
Beans, snap	0.50
Beets, roots	0.75
Beets, sugar, roots	0.50
Beets, sugar, tops	10.00
Beets, tops	0.70
Birdsfoot trefoil	40.00
Birdsfoot trefoil, hay	10.00
Blackberries	0.50
Blueberries	0.50
Boysenberries	0.50
Carrots	0.75
Celery	0.70
Cherries	0.75
Chicory, red (tops) (also known as radicchio)	0.70
Citrus	0.70
Clover (fresh)	40.00
Clover, hay	10.00
Corn, forage	40.00
Corn (inc. sweet K+CWHR)	0.70
Cottonseed	0.20
Cowpeas	0.10
Cowpeas, forage	0.10
Cranberries	0.50
Cucumbers	0.75
Dandelions	0.70
Dewberries	0.50
Endive (escarole)	0.70
Figs	0.50
Filberts	0.50

continued

K+CWHR = Kernals plus Cob with Husk Removed
Source: 40 CFR 180.153

Table IV-2., continued

Commodity	Tolerance (ppm)
Ginseng	0.75
Grapes	0.75
Grass (not more than 40 ppm shall remain 24 hours after application)	60.00
Grass, hay	10.00
Hops	0.75
Kiwi fruit	0.75
Lespedeza	1.00
Lettuce	0.70
Loganberries	0.75
Melons	0.75
Mushrooms	0.75
Nectarines	0.50
Olives	1.00
Onions	0.75
Parsley	0.75
Parsnips	0.50
Peaches	0.70
Peanuts	0.75
Peanuts, forage	40.00
Peanuts, hay	10.00
Peanuts, hulls	10.00
Pears	0.50
Peavine hay	10.00
Peavines	25.00
Peas with pods (determined on peas after removing any shell present when marketed)	0.50
Pecans	0.50
Peppers	0.50
Pineapples	0.50
Pineapples, forage	40.00
Plums (fresh prunes)	0.50
Potatoes	0.10
Potatoes, sweet	0.10
Radishes	0.50
Raspberries	0.50
Rutabagas	0.75
Sorghum, forage	10.00
Sorghum, grain	0.75
Spinach	0.70
Squash, summer	0.50
Squash, winter	0.75
Strawberries	0.50

continued

Table IV-2., continued

Commodity	Tolerance (ppm)
Sugarcane	0.75
Swiss chard	0.70
Tomatoes	0.75
Turnips, roots	0.50
Turnips, tops	0.75
Vegetables, leafy, *Brassica* (cole)	0.70
Walnuts	0.50
Watercress	0.70

Table IV-3. Malathion Residue Tolerances in Agricultural Commodities

Commodity	Tolerance (ppm)
Alfalfa (pre-h)	135
Almond hulls (pre-h)	50
Almonds (pre- and post-h)	8
Almonds, shells	50
Apples (pre-h)	8
Apricots (pre-h)	8
Asparagus (pre-h)	8
Avocados (pre-h)	8
Barley, grain (pre- and post-h)	8
Beans (pre-h)	8
Beets (including tops) (pre-h)	8
Beets, sugar, roots (pre-h)	1
Beets, sugar, tops (pre-h)	8
Birdsfoot trefoil, forage (pre-h)	135
Birdsfoot trefoil, hay (pre-h)	135
Blackberries (pre-h)	8
Blueberries (pre-h)	8
Boysenberries (pre-h)	8
Carrots (pre-h)	8
Chayote fruit	8
Chayote roots	8
Cherries (pre-h)	8
Chestnuts (pre-h)	1
Citrus, pulp, dehydrated (ct.f.)	50
Clover (pre-h)	135
Corn, forage (pre-h)	8
Corn, fresh (including sweet (K+CWHR)) (pre-h)	2
Corn, grain (post-h)	8
Cottonseed (pre-h)	2
Cowpea, forage (pre-h)	135
Cowpea, hay (pre-h)	135
Cranberries (pre-h)	8
Cucumbers (pre-h)	8
Currants (pre-h)	8
Dates (pre-h)	8
Dewberries (pre-h)	8
Eggplants (pre-h)	8
Eggs (from application to poultry)	0.1
Figs (pre-h)	8

continued

ct.f. = cattle feed
K+CWHR = Kernals plus Cob with Husk Removed
post-h = post-harvest
pre-h = pre-harvest
Source: 40 CFR 180.111 and 186.3850

Table IV-3., continued

Commodity	Tolerance (ppm)
Filberts (pre-h)	1
Flax seed	0.1
Flax straw	1
Garlic (pre-h)	8
Gooseberries (pre-h)	8
Grapefruit (pre-h)	8
Grapes (pre-h)	8
Grass (pre-h)	135
Grass, hay (pre-h)	135
Guavas (pre-h)	8
Horseradish (pre-h)	8
Kumquats (pre-h)	8
Leeks (pre-h)	8
Lemons (pre-h)	8
Lentils (pre-h)	8
Lespedeza, hay (pre-h)	135
Lespedeza, seed (pre-h)	8
Lespedeza, straw (pre-h)	135
Limes (pre-h)	8
Loganberries (pre-h)	8
Lupine, hay (pre-h)	135
Lupine, seed (pre-h)	8
Lupine, straw (pre-h)	135
Macadamia nuts (pre-h)	1
Mangoes (pre-h)	8
Melons (pre-h)	8
Mushrooms (pre-h)	8
Nectarines (pre-h)	8
Oats, grain (pre- and post-h)	8
Okra (pre-h)	8
Onions (pre-h)	8
Onions, (including green onions) (pre-h)	8
Oranges (pre-h)	8
Papayas (pre-h)	1
Parsnips (pre-h)	8
Passion fruit (pre-h)	8
Peaches (pre-h)	8
Peanut, forage (pre-h)	135
Peanut, hay (pre-h)	135
Peanuts (pre- and post-h)	8
Pears (pre-h)	8
Peas (pre-h)	8
Peavine, hay (pre-h)	8
Peavines (pre-h)	8

continued

Table IV-3., continued

Commodity	Tolerance (ppm)
Pecans (pre-h)	8
Peppermint (pre-h)	8
Peppers (pre-h)	8
Pineapples (pre-h)	8
Plums (pre-h)	8
Potatoes (pre-h)	8
Prunes (pre-h)	8
Pumpkins (pre-h)	8
Quinces (pre-h)	8
Radishes (pre-h)	8
Raspberries (pre-h)	8
Rice, grain (pre- and post-h)	8
Rice, wild	8
Rutabagas (pre-h)	8
Rye, grain (pre- and post-h)	8
Safflower, seed (pre-h)	0.2
Salsify (including tops) (pre-h)	8
Shallots (pre-h)	8
Sorghum, forage (pre-h)	8
Sorghum, grain (pre- and post-h)	8
Soybeans (dry and succulent) (pre-h)	8
Soybeans, forage (pre-h)	135
Soybeans, hay (pre-h)	135
Spearmint (pre-h)	8
Squash, summer and winter (pre-h)	8
Strawberries (pre-h)	8
Sunflower seeds (post-h)	8
Sweet potatoes (pre-h)	1
Tangerines (pre-h)	8
Tomatoes (pre-h)	8
Turnips (including tops) (pre-h)	8
Vegetables, leafy, *Brassica* (cole)	8
Vegetables, leafy, (except *Brassica*)	8
Vetch, hay (pre-h)	135
Vetch, seed (pre-h)	8
Vetch, straw (pre-h)	135
Walnuts (pre-h)	8
Wheat, grain (pre- and post-h)	8

Table IV-4. Inorganic Methyl Bromide Residue Tolerances in Agricultural Commodities (Resulting from Fumigation)

Commodity	Tolerance (ppm)
Alfalfa, hay (post-h)	50.0
Almonds (post-h)	200.0
Apples (post-h)	5.0
Apricots (post-h)	20.0
Artichokes, Jerusalem (post-h)	30.0
Asparagus (post-h)	100.0
Avocados (post-h)	75.0
Barley (post-h)	50.0
Beans (post-h)	50.0
Beans, green (post-h)	50.0
Beans, lima (post-h)	50.0
Beans, snap (post-h)	50.0
Beets, garden, roots (post-h)	30.0
Beets, sugar, roots (post-h)	30.0
Blueberries (post-h)	20.0
Brazil nuts (post-h)	200.0
Bush nuts (post-h)	200.0
Butternuts (post-h)	200.0
Cabbage (post-h)	50.0
Cantalopes (post-h)	20.0
Carrots (post-h)	30.0
Cashews (post-h)	200.0
Cherries (post-h)	20.0
Chestnuts (post-h)	200.0
Cippolini, bulbs (post-h)	50.0
Citrus citron (post-h)	30.0
Copra (post-h)	100.0
Corn (post-h)	50.0
Corn (pop) (post-h)	240.0
Corn, sweet (K+CWHR) (post-h)	50.0
Cottonseed (post-h)	200.0
Cucumbers (post-h)	30.0
Cumin, seed (post-h)	100.0
Eggplants (post-h)	20.0
Filberts (Hazelnuts) (post-h)	200.0
Garlic (post-h)	50.0
Ginger, roots (post-h)	100.0

continued

K+CWHR = Kernals plus Cob with Husk Removed
post-h = post-harvest
pre-h = pre-harvest
Source: 40 CFR 180.123

Table IV-4., continued

Commodity	Tolerance (ppm)
Grapefruit (post-h)	30.0
Grapes (post-h)	20.0
Hickory nuts (post-h)	200.0
Honeydew melons (post-h)	20.0
Horseradish (post-h)	30.00
Kumquats (post-h)	30.0
Lemons (post-h)	30.0
Limes (post-h)	30.0
Mangoes (post-h)	20.0
Muskmelon (post-h)	20.0
Nectarines (post-h)	20.0
Oats (post-h)	50.0
Okra (post-h)	30.0
Onions (post-h)	20.0
Oranges (post-h)	30.0
Papayas (post-h)	20.0
Parsnips, roots (post-h)	30.0
Peaches (post-h)	20.0
Peanuts (post-h)	200.0
Pears (post-h)	5.0
Peas (post-h)	50.0
Peas, blackeyed (post-h)	50.0
Pecans (post-h)	200.0
Peppers (post-h)	30.0
Pimentos (post-h)	30.0
Pineapples (post-h)	20.0
Pistachio nuts (post-h)	200.0
Plums (post-h)	20.0
Pomegranates (post-h)	100.0
Potatoes (post-h)	75.0
Pumpkins (post-h)	20.0
Quinces (post-h)	5.0
Radishes (post-h)	30.0
Rice (post-h)	50.0
Rutabagas (post-h)	30.0
Rye (post-h)	50.0
Salsify, roots (post-h)	30.0
Sorghum, grain (post-h)	50.0
Soybeans (post-h)	200.0
Squash, summer (post-h)	30.0
Squash, winter (post-h)	20.0
Squash, zucchini (post-h)	20.0
Strawberries (pre- and post-h)	60.0
Sweet potatoes (post-h)	75.0

continued

Table IV-4., continued

Commodity	Tolerance (ppm)
Tangerines (post-h)	30.0
Timothy, hay (post-h)	50.0
Tomatoes (post-h)	20.0
Turnips, roots (post-h)	30.0
Walnuts (post-h)	200.0
Watermelons (post-h)	20.0
Wheat (post-h)	50.0

Table IV-5. Methyl Bromide Residue Tolerances in Agricultural Commodities (Resulting from Soil Treatments)

Commodity	Tolerance (ppm)
Broccoli	25.0
Cauliflower	25.0
Eggplants	60.0
Muskmelons	40.0
Peppers	25.0
Pineapples	25.0
Strawberries	25.0
Tomatoes	40.0

Source: 40 CFR 180.199

uses contribute another 10% (Wofsy et al., 1975). EPA's STORET (a national monitoring program) water data base reports a median concentration of 67.5 μg/L in the atmosphere. Atmospheric concentrations of methyl bromide over the southern California coast between November 1982 and December 1983 ranged from 0 to 560 ppt. Halogen gases (such as bromine) in the atmosphere have been implicated in destruction of the ozone in the stratosphere (middle atmosphere); ozone forms a layer around the earth which protects it from excessive ultraviolet exposure. However, chlorine gases are thought to be the primary cause of ozone depletion and the small amounts of bromine in the atmosphere are not believed to be significant causes of ozone destruction.

In air, methyl bromide is rapidly removed by diffusion; concentrations decrease with increased distance from the fumigation area. Degradation is primarily by oxidative hydroxylation by which the fumigant reacts with molecules in the atmosphere to release inorganic bromine atoms (HBr, Br, or BrO). Rain then washes these atoms out of the air. At distances greater than 25 km (approximately 15½ mi) above the earth, light is responsible for the breakdown of methyl bromide (photolytic degradation).

Nonpersistent in soils, methyl bromide volatilizes quickly after rapid diffusion. The half-life of methyl bromide is on the order of hours (Winteringham, 1977). The rate of degradation is a function of moisture, clay content, organic contact, and compactness (e.g., soils with a high organic content accumulate more bromine from degradation processes than those with less organic matter). Leaching, as would occur with a soaking rain, would remove some methyl bromide and its breakdown products from the soil profile.

Methyl bromide has low water solubility; therefore, little is found dissolved in water. Volatilization and hydrolysis are the two important fate mechanisms for methyl bromide in water. It has a half-life of 1 to 5 days in average ponds, rivers, and lakes (EPA, 1986b). Hydrolysis yields hydrogen bromide and methanol; the process is pH-dependent and is enhanced in the presence of ultraviolet light. Bromine is water soluble, but concentrations in ground and surface water are from natural sources and are not due to methyl bromide degradation from agricultural use.

Commodity fumigation will occur prior to transport from the quarantine area. Because of financial and harvesting constraints, few fumigations are anticipated. Quantities of methyl bromide used will depend on the commodity and temperature, among other factors. Regulatory Program use of methyl bromide would allow some escape of methyl bromide to the atmosphere. Although it dissipates and degrades rather quickly, bromine (a halogen) can contribute to the reaction which converts ozone to atmospheric oxygen. However, regulatory use of methyl bromide is a minute portion of the agricultural use of the fumigant, which in turn is a very small contributor to the global load of bromine. Therefore, program use of this chemical will not result in a significant contribution to ozone depletion.

Deposition on soils and in water would not occur in any appreciable amount. No physical environmental effects are foreseen except in the unlikely event of an accident or spill. Registered and proper use of the fumigant and implementation of mitigative safety measures make this occurrence extremely unlikely. Any slight increase in environmental burden due to the limited use of the fumigant (or its degradation products) on soils, surface water, or ground water is considered negligible.

(2) Fate of Diazinon

Diazinon is a broad-spectrum organophosphate insecticide and nematicide widely employed for home, garden, and agricultural use against household pests (such as cockroaches), turf nematodes and grubs, fruit and vegetable pests, for seed treatment, and on pests of rangeland, pastureland, and ornamentals. Formulations include dusts, sprays, oil solutions, wettable powders, and granules (Meister, 1990). Technical grade diazinon is a sweet, aromatic amber-brown liquid. Oriental Fruit Fly Regulatory Program use will involve soil treatment for nursery stock only. The drench application will be limited to the drip line of the host plants and will occur immediately prior to plant transport.

The persistence of diazinon in soil is influenced by climate, soil temperature, moisture content, organic matter, and acidity. Nonbiological degradation is enhanced by soil acidity, higher soil temperature, and higher soil moisture content (Getzin, 1968). Under field conditions, 50% of the diazinon disappears from soil within 2 weeks; 95% of the remainder is in the top 4 inches (Bartsch, 1974). Diazinon leaches more readily in soils with low organic matter (EPA, 1984a). Increasing irrigation frequency may not increase leaching; even at high rates of irrigation, diazinon is retained in the upper few inches of soil where it is transformed. Diazinon, therefore, is unlikely to lead to ground water contamination (Bartsch, 1974).

Hydrolysis is the primary mechanism of diazinon degradation and results in several degradation products including diazoxon. Biological degradation (by soil microorganisms) plays a major role in the further breakdown of diazinon and its degradation products.

Photolysis is another mechanism of diazinon degradation on soil surfaces. Volatilization may also be an important loss mechanism, particularly on exposed surface areas experiencing high temperatures. The volatilization rate of diazinon increases with increasing concentration of the pesticide, temperature, and air flow rate and with decreasing soil organic matter content (Burkhard and Guth, 1981).

In the aquatic environment, diazinon degradation occurs by chemical hydrolysis and proceeds more rapidly in acidic environments and at higher temperatures (EPA, 1984a). It can persist for months in neutral or basic water. Volatilization rates have been recorded to be approximately ten times higher in water than soils at 30°C, but particulate and biological matter reduce these rates (Lichtenstein and Schulz, 1970). As in soil,

diazinon degradation and transport in aqueous systems is influenced by volatilization and sorption to soil particles (EPA, 1984a).

Based on a review of EPA's STORET water data base, the mean measured concentrations of diazinon were 1.7 μg/L in water and 2.48 μg/kg in mud of those samples that contained diazinon. Diazinon has low potential for bioconcentration in aquatic organisms. (EPA, 1984a).

Diazinon residues on fruits and vegetables average 1 to 5 ppm immediately after treatment, but decrease by half in 4 days. Residues on leafy vegetables are initially higher, but degradation is more rapid. Degradation is slower in crops with high oil content, such as oil seed plants. Only traces of diazoxon and other residues are detected in foodstuffs. Residues are the result of direct spraying, not from soil treatments, because plants do not appreciably translocate diazinon (Bartsch, 1974).

Only nursery stock stripped of any fruit will be subject to soil drenching with diazinon immediately prior to shipment. If the quarantine area includes substantial acreage planted in nursery stock, potential impacts would be somewhat greater than in areas planted in other crops because proportionately more pesticide would be used. However, all treatments are limited to the drip line of each tree.

Because the diazinon soil drench will be watered in, little will be available on the surface to volatilize; potential impacts to air media are negligible. Soils may contain small amounts of residual diazinon and degradation products, but diazinon degrades quickly. Because it does not leach from soils, neither ground water nor surface water will be impacted by use of diazinon in the Regulatory Program. In the unlikely event of a spill, all measures will be employed to contain the spill and clean up and dispose of any contaminated media according to all appropriate regulations. Proper use of the pesticide and mitigative measures will nearly eliminate this possibility.

(3) Fate of Malathion

Malathion is a broad-spectrum organophosphate insecticide and acaracide used to control aphids; sucking and chewing pests of vegetables, fruits, and stored products; flies in animal and poultry houses; mosquitoes for public health purposes; and human lice. Formulations include dusts, powders, emulsifiable concentrate, and oil solutions (Meister, 1990). For Oriental Fruit Fly Regulatory Program use, the amber-colored liquid is combined with a protein hydrolysate to form a sticky spray. Fruit flies are attracted to the bait and die after ingesting the malathion in the bait.

The half-life of malathion in soil ranges from hours to days and degradation rates increase with alkalinity, moisture, and temperature (EPA, 1984b). Hydrolysis is the primary pathway, although photolysis is important. Biodegradation is another pathway for both malathion and its breakdown products. Arthrobacter, a soil microbe, is known to degrade malathion to four metabolites, one of which is malaoxon.

Degradation in water usually proceeds more slowly than in soil and rates are dependent on light, temperature, pH, salinity, and biological activity. Higher alkalinity and salinity results in a shorter half-life (Wang, 1991). Transport in the aquatic environment depends on organic matter (adsorption), volatilization, or potential to bioaccumulate. Malathion is not expected to bioaccumulate in aquatic organisms. The mean concentration of STORET data stations reporting malathion was 1.31 µg/kg in whole water samples (EPA, 1984b). Under basic pH, products of malathion hydrolysis include malathion monoacids, which are more stable than malathion and a greater threat to aquatic life than the parent compound. However, the basic pH conditions leading to that hydrolysis would themselves already be a threat to aquatic life.

Malathion has low volatility and, therefore, does not volatilize to the atmosphere from soil or water. In both media, malathion adsorbs to organic matter; more leaching and volatilization may occur in soils with low organic matter and low pH (EPA, 1984b). An increased propensity to sorb in high organic soils reduces the possibility of malathion reaching ground water, but increases the possibility of contaminated runoff reaching surface water (Miles and Takashima, 1991).

Residues on food crops are lost fairly rapidly, with an average half-life of 5.2 days. Higher temperatures and moisture content increase the rate. Malathion does not persist when used repeatedly (Shirmohammadi, 1991).

Regulatory Program use includes ground and aerial application of malathion bait spray to host plants. Quantities will reach soil and possibly surface water. It is unlikely that malathion will reach ground water. The Regulatory Program's standard procedures, mitigations, and low application rates and malathion's rapid degradation make it unlikely that the Oriental Fruit Fly Regulatory Program will impact residues on commodities; tolerances for most commodities are 8 ppm (40 CFR 180.111) (see table IV-3, p. 30-32).

2. Human Health Risks

a. No Action

Under the no action alternative, it is likely that pesticide usage will be greater, both temporally and spatially, than with a Federal quarantine program in place. Consequently, more people will be exposed in a wider geographic area to higher levels of pesticides over a longer period of time to control or eradicate oriental fruit fly. The potential human health risks depend on the pesticides employed and their use, but could exceed risks from the other program alternatives.

b. Quarantine Only

Because the aim of this alternative is to contain the pest within the quarantine area, fewer people will be exposed to any pesticides potentially used in eradication or suppression efforts as a result of oriental fruit fly spread. Depending on the degree of infestation within the quarantine area, pesticides may be used by state and local governments, growers, and applicators.

The quantities of these pesticides and the rates of application could result in more exposure and consequent human health effects than the preferred alternative. If quarantine stations are set up, exposure to exhaust fumes would increase for quarantine officers. Noise and fumes may affect people living near these areas as well.

c. Quarantine and Commodity Certification

Quarantine and commodity certification would require the controlled infrequent use of pesticides. All chemical treatments will be conducted within the quarantine area, methyl bromide fumigations will be contained and infrequent, and soil drenching and malathion bait spraying would target regulated commodities and would be carefully controlled. Effects to humans from the program use of methyl bromide, diazinon, and malathion are anticipated to be negligible when used as specified. Slight increases in pesticide loading to nursery stock soil (diazinon) and commodities (methyl bromide and malathion) may occur. Risk to consumers from these increases is considered negligible.

Pesticide exposure would be primarily to workers, not the public. Pesticide applicators and, to a lesser extent, agricultural workers and harvesters potentially may be exposed to all program pesticides. To minimize exposure, field workers (including farm vehicle operators) will not be allowed in fields during malathion spraying or soil drenching, or within 30 ft of a fumigation chamber. They may return to the fields after the drench has completely dried. Malathion-treated produce cannot be harvested for 1 day after application. Worker safety measures should protect applicators during routine operations. Alternative chemical controls are not ordinarily used at the same time or place, thereby making any potential synergistic effects from the pesticides unlikely.

(1) Methyl Bromide - Toxicity and Exposure

Methyl bromide gas and liquid are acutely toxic to humans and other life. For this reason, it is a restricted-use pesticide which may be applied only by persons certified after extensive training and testing. Contact with liquid or vapors can cause serious skin or eye injury. Inhalation can cause acute illness including pulmonary edema (fluid buildup in the lungs), gastrointestinal distress, and convulsions which can be fatal. Chronic exposure can result in behavioral changes, loss of ability to walk, neurological damage, and renal and liver function disturbances (Verberk et al., 1979). The label instructions clearly indicate protective clothing requirements and self-contained breathing apparatus whenever concentrations of methyl bromide are anticipated to reach or exceed 5 ppm.

A NOEL (no observable effect level) of 0.065 mg/L (17 ppm) was determined for an 8-hour daily inhalation exposure for 6 months for the rabbit, the most sensitive laboratory animal species tested (Alexeeff and Kilgore, 1983). The rat LD_{50} (lethal dose for 50% of animals treated) is 2700 ppm for a 30-minute exposure. In humans, 1583 ppm (6.2 mg/L) methyl bromide is lethal after 10-20 hours of exposure and 7890 ppm (30.9 mg/L) is lethal after

1½ hours (EPA, 1986a). EPA's established acceptable daily intake (ADI) for methyl bromide inhalation for a 70 kg (approximately 154 lb) person is 0.021 mg/kg/day (EPA, 1986b). The American Conference of Governmental Industrial Hygienists (ACGIH) established exposure standards to alleviate potential health hazards. They are recommendations and, although not legally enforceable, many Federal standards conform to them. The ACGIH set a threshold limit value (TLV)/time-weighted average (TWA) for many chemicals. The TLV/TWA is the average concentration to which a full-time worker can be exposed daily without adverse effect. The TLV for methyl bromide is set at 5 ppm (20 mg/m^3) to protect against adverse neurotoxic and pulmonary effects (ACGIH, 1990).

Although the mode of action in humans is not well understood, methyl bromide is rapidly absorbed by the lungs and affects both the lungs and kidneys. Increased exposure to methyl bromide results in elevation of bromine levels in the blood; poisoning symptoms occur at a level of 2.8 mg/100 ml of blood (Curley, 1984). Methyl bromide has not been linked to reproductive abnormalities in humans or other mammals, nor has it been associated with sterility, fetotoxicity, embryo sensitivity, mutagenicity, or oncogenicity in animals tested (EPA, 1986b). However, chronic and subchronic toxicity is not well characterized and EPA recently reissued a call in notice to fill reregistration data gaps.

Acute exposure typically begins with a headache, dizziness, visual problems, gastrointestinal symptoms, and respiratory symptoms. In more extreme cases, muscular pain, numbness or twitching precede convulsions, unconsciousness, and possibly death. Increased exposure durations and higher concentrations increase the negative effects. Repeated exposures have the same effect as continuous exposure. Human deaths have resulted from exposures to high concentrations of methyl bromide or following higher than usual exposure after chronic low-level exposure (Alexeeff and Kilgore, 1983).

Possible routes of methyl bromide exposure include skin absorption, ingestion, and inhalation. Exposure to liquid methyl bromide can result from accidental splashing or by contact with contaminated clothing, including boots and gloves. A cool tingling sensation accompanied by numbness or pain are symptoms of dermal exposure (Alexeeff and Kilgore, 1983). Workers are trained and skilled in proper treatment procedures which should negate this potential exposure.

Ingestion of residues of methyl bromide and its degradation products is another exposure route. Within a few days of fumigation, methyl bromide volatilizes and degrades, leaving only inorganic bromide residues. However, residues from the methyl bromide fumigation will remain on the commodity. EPA tolerances for methyl bromide (40 CFR 180.123) range from 5 ppm (for apples, pears, and quinces) to 240 ppm (popcorn), with most commodities at 50 ppm or less. EPA has set the ADI for methyl bromide at 0.0014 mg/kg/day for oral exposure (EPA, 1986b). Ingestion of these small amounts of residues is not considered to have any toxicological effect based on scientific evidence. Ingestion of commodities fumigated with methyl bromide as

part of the Regulatory Program will add to any residues from other sources, but the increase is not considered to pose any appreciable risk.

Inhalation is the primary exposure route for methyl bromide. Because the gas is odorless and nonirritating during exposure, leaks and spills causing extreme exposure can occur without persons being aware of its presence and onset is delayed.

Although generally inflammable, if open flames contact methyl bromide, an acid (hydrogen bromide, HBr) is produced. When this acid contacts fabrics, metal or wood, compounds are formed that are very irritating to eyes, nose, and skin, and can adversely affect animal and plant life. For this reason, pilot lights or other open flames are not allowed to contact methyl bromide during fumigations.

Because methyl bromide is heavier than air, the gas can collect in isolated pockets, which could create hazardous conditions when there is little air circulation or mixing, such as during thermal inversions or periods of low wind. Proper sealing of fumigation enclosures will prevent escape of gas to low lying areas. In addition, proper aeration with upward ventilation will facilitate dispersal of the fumigant. Methyl bromide would be released to the atmosphere by aerating the chamber after fumigation. To minimize worker exposure, the chamber would be opened only after concentrations are reduced below 5 ppm.

(2) Diazinon - Toxicity and Exposure

Although diazinon is widely used and is generally considered safe at prescribed usage, it is toxic to humans. Depending on formulation, EPA classified its toxicity as Category I (Danger-Poison) or Category II (Warning). Diazinon has an acute oral LD_{50} of 618 mg/kg and an acute dermal LD_{50} of greater than 2000 mg/kg (EPA, 1988a). Although not a primary dermal or eye irritant, it can be absorbed through these routes and, at high concentrations or prolonged exposure, causes severe irritation. Gloves and safety goggles are indicated as protective clothing requirements on the label (Meister, 1990).

Accidental oral poisonings have resulted in death at doses between 50 and 500 mg/kg. A provisional ADI is set at 0.00009 mg/kg/day (EPA, 1988a). Diazinon is registered for use in food handling and feed handling/processing establishments; tolerances have been established for diazinon for a variety of commodities, in meat, and food additives (CFR 180.153, 185.1750, and 186.1750).

As an organophosphate, the mode of action of diazinon is acetylcholinesterase inhibition. The inhibition of the enzyme, acetylcholinesterase, allows the buildup of acetylcholine (an important component in nerve transmission) which poisons the central nervous system (Ware, 1989). Insects are extremely susceptible to the effects of diazinon, which induces hyperexcitability, tremors, convulsions, and paralysis. In mammals, which are orders of magnitude below insects with respect to susceptibility, this action occurs at

the neuromuscular junction causing muscle twitching. Symptoms of poisoning include dizziness, headache, blurred vision, nausea, vomiting, slurring of speech, and mental confusion. Death which occurs from high doses is from respiratory arrest caused by muscle paralysis and bronchoconstriction. In rats, plasma cholinesterase activity is the most sensitive indicator of diazinon exposure (EPA, 1984a). The lowest effect level (LEL) in human plasma is 0.2 mg/kg/day. A TLV/TWA of 0.1 mg/m^3 has been established by ACGHI.

Diazinon has many metabolites and some residues are long-lasting. Data on the toxicity of the metabolites is not currently available. Diazinon is not a potent cholinesterase inhibitor; it must be converted to diazoxon before poisoning can occur (Eisler, 1986). Diazinon is rapidly degraded which reduces its toxicity, but the metabolite diazoxon has a greater affinity for acetylcholinesterase and, thus, more toxicity resulting in delayed effects. Diazinon toxicity is related to the rates of metabolism from diazinon to diazoxon and decomposition to harmless products. Toxicity also may be due to toxic impurities that, in emulsifiableformulations, are increased with exposure to air (EPA, 1984a). Diazinon may exhibit synergistic effects with other commercial pesticide formulations currently in use. Diazinon is not considered to be a carcinogen and is nonmutagenic. Nonlethal diazinon cholinesterase inhibition is reversible (USDA, 1991).

Potential exposure to humans is by ingestion or dermal absorption. The soil drenching application techniques prevent inhalation exposure. In addition, program use of the pesticide precludes availability on foodstuffs because any fruit will be stripped from the plant before treatment.

In Regulatory Program use, potential exposure is primarily restricted to workers. Studies on exposure to diazinon during yard applications reveals that 85% of the exposure is to the hands. Protective covering can prevent such exposure and is a routine component of the Oriental Fruit Fly Regulatory Program. Program workers are monitored for cholinesterase levels and exposure will be less than the time-weighted average because of protective clothing, the small quantities used, and limited soil drench applications. In addition, all EPA field reentry requirements will be met to protect agricultural personnel. Workers may not enter the fields within 48 hours of pesticide application without protective clothing which includes full coverage of arms, legs, and head (Ware, 1989). Nursery workers and/or consumers could be exposed to residual diazinon during repotting activities, but the risks from this would be negligible.

(3) Malathion - Toxicity and Exposure

Malathion is a nonsystemic insecticide with ingestion, contact, and respiratory action. It is used on crops: food and nonfood, greenhouse, and aquatic (cranberries and rice). It is mildly acutely toxic, classified by EPA as Category III (Caution) based on oral, dermal and inhalation exposure routes. Acute oral toxicity ranges from 1522 to 1945 mg/kg; dermal toxicity is greater than 2000 mg/kg; and acute inhalation ranges from 1.7 to greater than 4.0 mg/m^3 in rats (EPA, 1988b).

Malathion is an acetylcholinesterase inhibitor which reduces the activity of plasma and red blood cell cholinesterase. Toxic effects from malathion include headache, nausea, vomiting, blurred vision, weakness, and muscular twitching at high doses.

In humans and other mammals, metabolism is by oxidative desulfuration which leads to the formation of malaoxon, a more potent cholinesterase inhibitor than malathion. The more common degradation pathway is hydrolysis which yields nontoxic intermediates. Based on human plasma cholinesterase inhibition, the LEL has been set at 0.34 mg/kg and a NOEL established at 0.2 mg/kg/day. Malathion may have synergistic effects when used with other pesticides.

Tolerances for malathion on many food items are established (40 CFR 180.111) and most are 8 ppm. The provisional acceptable daily intake (PADI) is 0.02 mg/kg/day. EPA estimates the theoretical residue contribution for the population average is 507% of the PADI, which assumes that 100% of the commodity growing sites are treated. Although more data are required by EPA on malathion residue tolerances on most commodities, malathion is not under special review. However, no new uses will be permitted until data gaps have been filled. Although malathion has not been determined to be a carcinogen in rats, additional data on malathion and malaoxon are equivocal and studies are ongoing. More information is needed to determine the neurotoxicity of malathion (EPA, 1988b).

Exposure to malathion can result from ingestion, dermal contact, or inhalation. Residues on commodities resulting from the regulatory bait spray program are unlikely to greatly increase residues to the consumer. Any exposure that would occur to the bait spray applicators will be mitigated by regulatory and safety precautions taken by skilled and trained workers to avoid direct exposure to the spray. Agricultural workers will be protected by reentry requirements which stipulate all sprays must be dried before returning to the spray area. Nonworkers are unlikely to be exposed because spraying will be limited to quarantined, regulated areas; off-site drift will be minimal. Spills from concentrated malathion of the dilute formulation may present significant risk to workers and nonworkers experiencing direct contact. All safety precautions will be employed to avoid this possibility.

3. Potential Effects to Nontarget Organisms

a. No Action

Without APHIS regulatory action to impose either quarantine only or quarantine and commodity certification, there is increased risk of pest movement away from the infestation epicenter. If the infestation were to spread, state and local governments and growers and applicators might respond with pesticide applications. Because the response, including pesticide type, quantities, and application methods are unknown, specific risks to nontarget organisms are inestimable, but would likely be higher than without the Federal program. The potential impact of oriental fruit fly establishment on nontarget species is difficult to predict. However, in addition to high impacts on host organisms, established populations would undoubtedly

affect insect species dynamics and could impact predatory and insectivorous populations.

b. Quarantine Only

Because the quarantine program would limit the spread of the infestation, other entity response to suppress or eradicate within the quarantine area would be more localized. As with the no action alternative, potential pesticide usage within the quarantine area is unknown, but would likely be less outside the quarantine area if the quarantine is put into place. Nontarget organisms could be at increased risk due to human activity near quarantine stations (e.g., traffic congestion and exhaust). Destruction of commodities could result in loss of host material for several species, although impacts probably would not be great. Potential air quality changes resulting from commodity burning could also affect nontarget organisms.

c. Quarantine and Commodity Certification

(1) Terrestrial Effects

(a) Methyl Bromide

Based on laboratory studies of the effects of methyl bromide inhalation and ingestion, other mammals and birds exhibit symptoms similar to humans: weakness, lack of muscular coordination, neurological and behavioral abnormalities, and death from high doses. Methyl bromide and degradation products are involved. Animals vary in their sensitivities to methyl bromide; the rabbit is most sensitive to inhalation. As in humans, the effects of repeated exposures are similar to acute high level doses. Methyl bromide fumigation of poultry houses, litter, and food often is used to control *Salmonella*; few effects are noted when these areas are properly aerated. However, a turkey kill was documented downwind from an improperly contained fumigation. Toxic effects from residues in foods have been observed in livestock and degradation products (bromide) can accumulate in tissues.

Any nontarget organisms, at any life stage, within or on the host commodity will be killed during fumigation. This is a positive effect. Nontarget species living on or in the commodity will not be inventoried or protected from the effects of methyl bromide fumigation. The elimination of any possible beneficial invertebrates harbored by the commodity will also occur and cannot be avoided. Outside the fumigation area, nontarget beneficial organisms potentially are exposed to the aeration plume. Bees are the primary organism of concern and some individual bees possibly could be affected. Methyl bromide is used as a honey and bee comb fumigant and with proper airing apparently does not affect the bees. Little or no direct effect is anticipated on individual bees foraging adjacent to the treatment area.

The infrequent fumigations that will be conducted in the Regulatory Program and the implementation of proper aeration procedures will effectively prevent exposure to wildlife, livestock, and pets. Before fumiga-

tions commence, the areas surrounding the chamber/building will be surveyed, especially downwind areas, for any wildlife, particularly nesting species and grazing livestock. This will be especially critical during breeding seasons. Efforts will be made to prevent pets and other species, such as birds, from entering the aeration plume during aeration. No animals will be allowed in the 30-ft control area. The carefully controlled conditions of application and the implementation of standard protective measures and monitoring procedures negate direct risk to nearly all wildlife species that may exist near the treatment area.

Although methyl bromide does not harm most plants, some varieties are more susceptible to effects from methyl bromide fumigation than others. Aeration of the fumigation chamber will result in release of methyl bromide to the atmosphere. Most facilities are somewhat isolated and are not placed near living plants. Nontarget plants near the fumigation facilities should not receive doses sufficient to cause damage due to low exposure concentrations and infrequency of the activities.

(b) Diazinon

Animals also differ in their sensitivity to diazinon, both within and between species. Toxicity varies widely and depends on sex and life stage as well as environmental factors. Diazinon is toxic to vertebrate laboratory animals (LD_{50} of 240 mg/kg in guinea pigs) and very toxic to livestock (LD_{50} of 0.5 mg/kg in calves). Mild responses in sheep include dullness and anorexia (USDA, 1991). The LD_{50} for a bullfrog is greater than 2000 mg/kg.

A lethal concentration to 50% of the exposed rats (LC_{50}) in 4 hours is 2.3 to 3.5 mg/L (USDA, 1991). Rat oral LD_{50} is 300 to 400 mg/kg for technical grade (Meister, 1990), but formulations are often less toxic (910 to 1830 mg/kg) (USDA, 1991). Evidence exists that female rats are more sensitive than male rats to oral doses of diazinon (Davies and Holub, 1980). Diazinon exhibits potentiation with malathion in mice (Finkelstein, 1969 as cited in USDA, 1991). Developmental toxicity has not been demonstrated in rodents nor is diazinon oncogenic (EPA, 1988a).

Although diazinon is moderately toxic to mammals, it is extremely toxic to birds. Birds are more sensitive because their blood has no enzymes to hydrolyze diazoxon (the more toxic metabolite), as does mammalian blood (Eisler, 1986). Signs of intoxication include salivation, stiff-legged gaits, wing spasms, and wing-beat convulsions (Hudson et al., 1984). The oral LD_{50} is 2.0 mg/kg for red-winged blackbird, 3.54 mg/kg for mallard, and 110 mg/kg for European starling (Smith, 1987). Many avian die-offs have occurred due to the use of diazinon, particularly geese and other waterfowl, on golf courses. These incidents led EPA to cancel use of diazinon on golf courses and sod farms in 1986.

In addition to higher toxicity, diazinon is also a known teratogen to birds; effects have been shown in chick embryos. Diazinon is toxic to 18-week-old turkeys at 5 mg/kg dermally, but no birds were poisoned when soil was treated with 16 lb/acre a.i. spray (Radeleff and Kunz, 1972).

Terrestrial invertebrates are much more sensitive to diazinon: butterfly LD_{50} is 8.8 mg/kg and honey bee LD_{50} is 0.372 µg per bee (USDA, 1991). The primary nonlethal effect is reduction of worker life span (longevity); emergent bees are more sensitive than older honey bees (MacKenzie and Winston, 1989). Diazinon causes high earthworm mortality, but does not have a similar affect against nematodes. Natural parasites can be affected by diazinon as well (Coster and Ragenovich, 1976). There is evidence of some bioaccumulation. Although hornworms in sprayed tobacco fields did not present a hazard to birds eating them, slugs in wheat fields sprayed with diazinon caused concern for bird predators. Insectivores (insect eaters) also may be affected by a reduced food supply.

Diazinon translocates quickly in legumes (beans and peas), both from roots (to leaves and stems) and to roots from above-ground parts. The amount absorbed is insufficient to exhibit insecticidal activity. In addition to unchanged diazinon, pyrimidinol and hydroxy-pyrimidinol are formed. Diazoxon was not detected in legumes, possibly indicating that diazoxon is rapidly hydrolyzed (Bartsch, 1974).

Diazinon remains biologically active in the soil for 6 months or more. In addition to reduction in earthworms, populations of other soil-dwelling organisms will be reduced. This will include certain life stages of insects and their predators. In addition, nutrient cycling in the soil may be affected in areas sprayed but not removed with the host plant from the site. It is unlikely that any plant uptake would affect consumers.

(c) Malathion Bait Spray

Oral doses of malathion are slightly to moderately acutely toxic to mammals and birds. Typical LD_{50}s for test birds and rodents range from 167 mg/kg (for female ring-necked pheasant) to 1375 mg/kg (for rat) and 1485 mg/kg (for mallard) (Smith, 1987). Signs of poisoning are similar to the reactions in mammals. Malathion can penetrate turtle eggs and cause malformed embryos (Mitchell and Yntema, 1973 as cited in EPA, 1984b).

Malathion bait spray will attract insects other than the oriental fruit fly, including other pest species. A possibility does exist that some beneficial insects, including predators of these pests, may also be attracted, ingest the bait, and die. The localized reduction in prey population for insectivores could have an affect on these species. Because they can forage elsewhere, however, effects are expected to be minimal.

Malathion is highly toxic to bees. Direct spraying will result in high mortality, but distance from application area and type of area sprayed will affect the survival of bees. Areas which are characterized by large quantities of blooming crops or weeds can be expected to suffer a high bee kill. The residual hazard of insecticides to bees increases with temperature. Hive contamination and colony destruction can occur when contaminated pollen is collected by foraging honey bees. Despite the known effects on bees, a significant impact on the bee populations is not projected as a consequence of the Oriental Fruit Fly Regulatory Program. There are several reasons for

this, including: (1) the limited scope of the program—only regulated host crops are targeted, (2) the agricultural producers of those host crops have their own pest control regimes, (3) the bee populations naturally regenerate and repopulate, and (4) commercial apiarists will be notified when chemical controls will be used in their areas.

There could be potential indirect effects on plant populations because of reduced pollination if bees or other pollinators are reduced in number. Those effects are expected to be minimal for the same reasons that the program's effects on bees will be minimal.

Malathion is not considered phytotoxic. Data pertaining to malathion uptake, distribution, and metabolism are inadequate to define these processes (EPA, 1988b).

(2) Aquatic Effects

There is no information to evaluate the toxicity of methyl bromide to aquatic organisms. However, it is unlikely that aquatic organisms will be exposed, even in the unlikely event of a spill, because of the volatility of methyl bromide. Any spills of program chemicals, whether in terrestrial or aquatic environments, will be cleaned up rapidly and will tend to dissipate quickly. If water bodies are affected, proper authorities, such as state fish and wildlife departments, will be contacted promptly.

Freshwater cladocerans, daphnids, and marine shrimp are the species most sensitive to diazinon of those tested, with a 96-hour LC_{50} of less than 5 µg/L. There is some evidence that juvenile fish are more sensitive than eggs (96-hour LC_{50}s of 27.8 and 3200 µg/L, respectively for striped knifejaw). Sublethal effects include reduced growth and reproduction in both marine and freshwater invertebrates, including reduced emergence of insects and accumulation and possible mutagenicity in fish (Eisler, 1986). Freshwater and marine algae are unaffected by concentrations fatal to aquatic invertebrates. Predator reduction could affect algal species composition and dynamics. Because leaching and runoff are unlikely with Oriental Fruit Fly Regulatory Program use of diazinon (except in the unlikely event of a spill), risks to aquatic organisms are considered negligible.

Malathion is potentially highly toxic to aquatic life, including invertebrates, amphibians, and fish. The growth of several algal species is inhibited by as little as 10 mg/L of malathion. Daphnia and other invertebrates have a 96-hour LC_{50} of less than 1.0 µg/L (EPA, 1984b). EPA has established a water quality criteria of 0.1 µg/L for protection of freshwater and marine aquatic life. Of the fish species, salmonids and centrarchids (e.g, trout, bluegill) are the most sensitive to malathion (most 96-hour LC_{50}s are less than 100 µg/L). Fish kills have been documented from aerial malathion spraying. In general, the Oriental Fruit Fly Regulatory Program will preclude applications to water. Use of the backpack sprayer to spray host plants in localized areas ensures precise targeting. In the event the program must use aerial sprays (the program occurs in or expands to an area with large acreage in commercial host plants), proper program procedures and mitigative mea-

sures will be employed to avoid application to recognizable water bodies. In the unlikely occurrence of a spill near water, all applicable local, state and Federal laws will be followed with regard to notification and remediation.

4. Endangered and Threatened Species

Potential effects presented above for nontarget organisms apply equally to endangered and threatened species. However, because of small and often localized populations which cannot be jeopardized, additional factors must be considered. As needed, program personnel will request information about listed and candidate Federal and state endangered and threatened species. Appropriate protection measures, as required by site-specific circumstances, will be applied to ensure the protection of endangered and threatened species.

No Federal or state listed, proposed, or candidate species will be directly exposed to program methyl bromide fumigation. Methyl bromide fumigation is a highly controlled and contained procedure which, by nature, offers minimal potential for contamination of the surrounding environment. Because of standard program safeguards which further minimize the potential for contamination of surrounding areas, no adverse effects are anticipated for species existing outside the treatment premises. It is also unlikely that listed species will inhabit locations near the fumigation area, although this will be verified before the program begins. In the event a listed species is in the area, APHIS will consult with FWS regarding protective measures for that species and proceed only after a concurrence has been reached with FWS. No direct effects to endangered and threatened species are anticipated as a consequence of the Regulatory Program fumigation.

The Endangered Species Act (ESA) section 7 requires that Federal agencies consult with FWS on any agency action which could potentially affect a federally listed endangered or threatened species or its listed critical habitat. In formal section 7 consultation, the Agency prepares a biological assessment which analyzes potential effects of its proposed action or program on endangered and threatened species. The Agency forwards its biological assessment to FWS, which, following comprehensive review, then issues a biological opinion which concludes no exposure, no jeopardy, or jeopardy for each species.

ESA and section 7 consultation apply also to EPA's approval of pesticide registrations. EPA's consultation with FWS continues as EPA obtains new data and information and as registrations change. EPA has initiated an Endangered Species Protection Program which has developed additional uniform labeling restrictions for use of pesticides within the range of endangered and threatened species.

In FWS' Final Biological Opinion (USDI, 1989) for the EPA program, a jeopardy opinion was issued for several species for diazinon and malathion, two Oriental Fruit Fly Regulatory Program chemicals. FWS has offered reasonable and prudent alternatives to protect these species.

Generally, reasonable and prudent alternatives for listed species protection will be implemented, along with others as they are issued or revised. Many of these recommendations are included in the Oriental Fruit Fly Regulatory Program mitigative measures as standard procedures. In some instances these procedures exceed requirements; e.g., the program conducts no applications to aquatic environments. However, under the EPA Endangered Species Protection Program, there are provisions for an agency to consult directly with FWS and gain concurrence for protective measures which may be less restrictive than those established by EPA for the pesticide label or developed by FWS as "reasonable and prudent alternatives" for EPA. It is important to remember that APHIS will reach a concurrence with FWS for the protection of endangered and threatened species which potentially could be affected by the program. The key provision is that the necessary protective measures are established through consultation with FWS.

Because any endangered and threatened species within a program area will be identified and appropriate protective measures will be implemented, no effects on listed species are anticipated from the Oriental Fruit Fly Regulatory Program. When an endangered or threatened species is within or near the program area, APHIS will consult with FWS to ensure its protection.

5. Cumulative Impacts

Cumulative impacts are those impacts, either direct or indirect, that result from incremental impact of the program action when added to other past, present, and reasonably foreseeable future actions. It is difficult to predict in a quantitative sense, cumulative impacts for a potential emergency program in a programmatic environmental assessment such as this. The impacts can be considered from a subjective perspective.

The Oriental Fruit Fly Regulatory Program will result in a slight, temporary increase in pesticide load to the environment. This increase brings slight additional exposure and potential risk to certain organisms. With USDA quarantine and commodity certification, program goals of containing the pest will be achieved. The successful implementation of eradication and regulatory programs will eliminate the need for further controls, thereby negating any future environmental impact.

However, if oriental fruit fly were allowed to spread from its point of introduction, as in the no action alternative, and pest populations continued to increase, the states, local governments, commercial growers, and individuals would respond with their own control programs. Under such conditions, there would be less managerial control over the applications and the applications would include pesticides which vary in respect to their environmental consequences. Higher application rates and more frequent applications would increase exposure and resultant risk to humans and nontarget species. With an established oriental fruit fly population, the use of pesticides could increase indefinitely.

The Oriental Fruit Fly Regulatory Program will be temporary, lasting only until the infestation is eradicated. Therefore, the cumulative impacts of the program are expected to be considerably less than those for no action.

6. Unavoidable Environmental Effects

Unavoidable effects are difficult to determine under the no-action or quarantine-only scenarios. The pest's success and response to its environmental conditions would determine to a great extent the actions taken by growers and responsible organizations to counter the pest. Although the control actions, including uncoordinated chemical applications, cannot be considered unavoidable (although they are uncontrollable by APHIS), they could be expected to have substantial adverse environmental effects.

The quarantine and commodity certification alternative would also have associated unavoidable environmental effects. There would be an unavoidable increased pesticide loading to the environment, although it likely would be less than without a program. The increased loading includes diazinon to the soil, methyl bromide to commodities and air, and malathion to host stock and commodities. The increased loading would result in increased exposure to pesticide workers, field workers, and perhaps to consumers. Other nontarget organisms would also be affected by methyl bromide fumigation, soil treatment, and bait spray applications. Proper timing and incorporation of mitigative measures will alleviate the impact, but insects attracted to the bait, susceptible organisms in the soil, organisms in the fumigation chambers, and perhaps in the aeration and spray plume could be affected. The loss of pollinators, parasites, and soil organisms should be minimal due to the limited number and scope of treatments.

Organic farmers whose lands are within the quarantine area may be affected by the Regulatory Program. In order to sell or ship their produce outside of the quarantine area, treatment and certification will be necessary. Vapor heat treatment or cold treatment are two approved treatments that may be acceptable to organic farmers for certification of their products.

Potential increased traffic congestion would also increase noise, exhaust, and have impacts on nearby populations.

V. Program Mitigative Measures

A. Introduction

The mitigative measures that have been developed for the Oriental Fruit Fly Regulatory Program reflect the concern of APHIS and our cooperators for protecting and conserving environmental quality within the potential program areas. Eliminating the threat to agriculture imposed by introduction of the oriental fruit fly, while still preserving the quality and diversity of the human and natural environment, is the goal of the mitigative measures. The rationale for the mitigative measures is summarized and a concise compilation of the mitigative measures is provided in this section.

The quarantine and commodity certification alternative involves the applications of certain treatments to certify regulated articles for movement to areas outside the quarantine area. Malathion is an insecticide commonly used worldwide for agricultural purposes. This insecticide, characterized by low mammalian toxicity, will be applied in a controlled manner which has been calculated to minimize environmental risk and to reduce exposure to nontarget organisms over conventional insecticide applications which lack bait spray technology. This Regulatory Program will limit applications of malathion bait spray to the fields or orchards where the regulated commodities are grown. This limits the scope of the program. Likewise, the soil treatments with diazinon are restricted to regulatory applications to the drip line of the host plants.

Potential consequences of any pesticide treatment include inadvertent application outside designated treatment areas and accidental spills. To minimize such effects, the Oriental Fruit Fly Regulatory Program has put a significant effort into the development of training, operational procedures, and mitigative measures. Sensitive areas in the vicinity of the treatment areas will be identified and evaluated with respect to use of alternative control technologies. In the unlikely event that an accidental spill of insecticide occurs, established procedures provide for efficient and safe containment of the spill and elimination of any potential hazard.

In addition to field applications, the quarantines include the option of fumigation of the regulated commodities with methyl bromide. An APHIS representative supervises all required fumigations. It is the APHIS representative's responsibility to ensure that the fumigation procedures adhere to the safety measures prescribed on the fumigant label or exemption and the Plant Protection and Quarantine Treatment Manual. A secured area is clearly marked with hazard warning signs and separated by physical barriers around the fumigation enclosures. Entry to this area during fumigation is restricted to individuals wearing self-contained breathing apparatuses. Adherence to procedures and instructions are verified by actual checking of the volume and dosage calculations, dosage applications, gas concentrations, and safety measures. Quarantine fumigations are performed only by individuals who are properly licensed and certified.

Each participant in fumigation is required to have training in proper application procedures, hazard awareness, first aid procedures, and proper use of approved respiratory protection. All persons are required to use self-contained breathing apparatuses when installing the exhaust system, opening the tarpaulin for aeration, and at any other time during the fumigation or aeration process when there is the possibility of exposures above the threshold limit value.

The Oriental Fruit Fly Regulatory Program has a comprehensive program to train and maintain competency of their personnel relative to application procedures, safety precautions, and adherence to established mitigative procedures. All applicators are trained concerning proper operational procedures, application procedures, delineation of treatment areas, local conditions, and safety considerations. Each applicator is briefed again before applications and provided with any site-specific considerations for the area to be treated. This thorough approach prevents application errors which could result in ineffective or unnecessary applications resulting from a lack of knowledge of specific considerations for the treatment area.

Protection measures have been designed to ensure the conservation of the nontarget plants and animals. Many of the endangered or threatened species live in areas which are remote or not targeted for potential oriental fruit fly quarantine treatments. These species will not be affected by any aspect of the program. When an endangered or threatened species exists within a proposed treatment area, the Oriental Fruit Fly Regulatory Program will employ protective measures established for that species through coordination with FWS or corresponding agencies of the state governments. Mitigative procedures provide the required protection by means of a buffer zone around recognizable water resources which should protect nontarget aquatic organisms. Many plants rely upon insects for pollination. Protection of pollinators is an economic consideration for some crops. Legal and social implications also must be considered with regard to protection of pollinator species. The Oriental Fruit Fly Regulatory Program addresses protection of pollinators through a series of mitigative measures involving application procedures, protective buffer zones, and technical advice and assistance where appropriate.

A comprehensive monitoring plan has been developed to ensure that the mitigative measures have achieved their desired goal. The monitoring plan is designed to specifically assess concerns with regard to public safety and health, proper application of pesticides, and protection of nontarget species including pollinators.

B. Mitigative Measures

All facets of the Oriental Fruit Fly Regulatory Program activities will incorporate measures to protect human health and the environment. Before the program is implemented, sensitive areas within the projected program area will be delineated. Notification procedures will be invoked to alert the public and apiarists. Climatic conditions which could decrease the accuracy

of placement of chemicals and, thereby, cause adverse impacts will be avoided. In all cases, site-specific aspects will be taken into consideration for each regulatory treatment. Following is a list of mitigative measures for all aspects of the program.

1. General Mitigative Measures

a. All applicable environmental laws and regulations will be followed.

b. All materials will be handled, stored, used, and disposed according to applicable laws and to minimize potential impact to human health and the environment.

c. All program personnel will be instructed on procedures and the proper use of equipment and materials. Field supervisors will emphasize these procedures and monitor the conduct of personnel.

d. All materials will be applied in such a manner as to avoid any recognized potential impact on the endangered and threatened species identified prior to program implementation.

e. Sensitive areas (including reservoirs, lakes, streams, parks, zoos, and recreation areas) near treatment areas will be identified by the state. The program will utilize appropriate control alternatives, including buffer zones, to ensure that these areas are not adversely affected.

f. Program activities will be timed to minimize potential exposure to the public and nontarget organisms. This will include consideration of the appropriate weather conditions.

g. Activities will be tailored, within the program scope, to the specific site on which they will occur to maximize program efficiency and minimize potential adverse effects.

h. Environmental monitoring of the program will be conducted in accordance with the environmental monitoring guidelines (section VI, p. 59) included in this document.

2. Chemical Applications

a. All materials will be applied strictly according to label instructions or as stipulated in an applicable EPA exemption.

b. All mixing, loading, and unloading will be in an area where an accidental spill will not contaminate a stream or other body of water.

c. Any insecticide spills will be cleaned up immediately and disposed of in a manner consistent with the label and any local regulations regarding disposal of insecticide contaminated waste.

d. All pesticides will be stored according to EPA guidelines and local regulations. Pesticide storage areas will be inspected periodically.

e. All program personnel will be instructed on emergency procedures to be followed in the event of insecticide exposure. Equipment necessary for immediate washing procedures will be available.

f. Chemical pesticides applicators will be required to have periodic cholinesterase testing.

g. All APHIS employees who plan, supervise, recommend, or perform pesticide treatments are also required to know and meet any additional state and local qualifications or requirements of the area where they perform duties involving pesticide use.

h. Applicators, loaders, and other personnel handling insecticides will be advised to wear proper safety equipment and protective clothing.

i. Unprotected workers will be advised of the respective reentry periods following treatment in agricultural crop areas. For malathion and diazinon, workers should not reenter the field until the material has dried.

3. Aerial Applications

a. Prior to beginning operations, aerial applicators will be briefed by program staff regarding operational procedures, application procedures, treatment areas, local conditions, and safety considerations.

b. Aerial application sites will be inspected prior to any treatment to determine the presence and nature of sensitive areas. In cases where aerial applications would result in an unacceptable potential risk to a sensitive area, the program manager(s) will determine the need for approved alternative controls, as described in this analysis.

c. Flags or other markers will be used in areas without natural landmarks for pilot guidance.

d. No aerial chemical applications will be made within 200 meters of any recognized body of water. When necessary, aerial markers are placed to indicate the buffer zones around water bodies. Aerial chemical applications will not be made where water contamination poses a major concern.

e. Applications are made by helicopters in areas of rough terrain. This enhances accurate placement of controls and increases the safety of applicators.

f. To the degree possible, insecticides will be delivered and stored in sealed bulk tanks, and then pumped directly into the aircraft.

g. Aerial applications will not be made when any of the following conditions exist in the treatment area: wind velocity exceeds 10 mph, rain is falling or is imminent, weather is foggy, air turbulence exists that could seriously affect the normal spray pattern, or temperature inversions exist that could cause off-site movement of spray. These restrictions reduce the potential for runoff and drift of aerially applied chemicals.

h. Program personnel will use cards sensitive to malathion bait (dye cards) to determine swath width during calibration and monitoring. Dye cards are used in monitoring to validate swath width and droplet size, and for evaluation of the potential for drift.

4. Ground Applications

a. Ground applications of chemical pesticides will be made to oriental fruit fly host environments only.

b. Ground application sites will be inspected prior to any treatment to determine the presence and nature of sensitive areas. In cases where ground applications would result in an unacceptable potential risk to a sensitive area, the program manager(s) will determine the need for approved alternative controls, as described in this analysis.

c. Ground chemical applications will not be made where water contamination poses a major concern.

d. Before beginning operations, the oriental fruit fly staff will brief ground applicators regarding operational procedures, application procedures, treatment areas, local conditions, and safety considerations.

e. Ground chemical applications will not be made in areas occupied by unprotected workers.

f. To the degree possible, insecticides will be delivered and stored in sealed bulk tanks, and then pumped directly into the mixing tank of the ground application equipment.

g. Ground applications will not be made when any of the following conditions exist in the treatment area: wind velocity exceeds 10 mph, rain is falling or is imminent, weather is foggy, air turbulence exists that could seriously affect the normal spray pattern, or temperature inversions exist that could cause off-site movement of spray. These restrictions reduce the potential for runoff and drift of applied chemicals.

h. Program personnel shall notify workers in the regulatory treatment area in advance of the date and time of planned quarantine treatments. Notifications will be in both English and Spanish because many of the treatment areas have workers who speak either one of these languages.

5. Fumigation

a. All fumigations will be conducted within the quarantine area.

b. An APHIS representative who is trained in proper application procedures, hazard awareness, first aid procedures, and proper use of approved respiratory protection will supervise all quarantine fumigations.

c. Quarantine fumigations will be conducted by individuals who are properly licensed and certified.

d. All fumigations will be conducted according to the label or exemption and will be in compliance with all Federal, state, and local regulations.

e. A secured area will be clearly marked with hazard warning signs and separated by physical barriers around the fumigation enclosures. Entry to this area during fumigation will be restricted to individuals wearing self-contained breathing apparatuses.

f. Use of drip shields will be required at the outlet nozzle to collect any liquid fumigant and protect the harvested commodity from potential damage due to chemical burns.

g. Halide detectors will be used to check for leaks around the fumigation enclosure. Any leaks will be blocked immediately.

h. The base of the fumigation enclosure will be a surface impervious to methyl bromide gas penetration.

i. Adherence to procedures and instructions will be verified by the APHIS representative who is required to check the volume and dosage calculations, dosage applications, gas concentrations, and safety measures.

j. All persons will be required to use self-contained breathing apparatuses when installing the exhaust system, opening the tarpaulin for aeration, and at any other time during the fumigation or aeration process when there is the possibility of exposures above the threshold limit value.

6. Pollinator Protection

a. Program personnel will notify any known bee keepers of apiaries in or near areas scheduled for regulatory treatments of the time and date of quarantine treatments.

b. Program personnel will advise bee keepers to confine their bees to the hives covered with burlap during the day of application.

c. Program personnel will make available technical advice to bee keepers about protective measures.

d. Regulatory applications are made to host plants (malathion) and the soil up to the drip line of host plants (diazinon). These application restrictions ensure that direct application will not be made to any apiaries in the area.

VI. Monitoring

The monitoring program consists of monitoring the environmental consequences of the chemical treatments used in the Regulatory Program. A site-specific environmental monitoring plan will be developed following the activation of the Regulatory Program. Monitoring to determine program efficacy will be conducted by trained personnel as described and discussed in the Plant Protection and Quarantine Treatment Manual.

For each of the three chemical treatments (methyl bromide fumigation, diazinon soil drench, and malathion bait spray), the purity of the chemical and accuracy of the formulation will be determined. Standard operating procedures described in the Plant Protection and Quarantine Treatment Manual will be used during the treatments to ensure that adequate safety precautions are taken and any label requirements of the chemical are met.

Environmental monitoring of the methyl bromide fumigation treatment will consist of ensuring that the tolerances for methyl bromide in agricultural commodities are not exceeded during the fumigation treatment. Tolerances for methyl bromide in agricultural commodities are given in table IV-4 (see p. 33-35).

If treatment of a premises is required, the environmental monitoring will consist of testing for possible environmental consequences of the treatment and testing of agricultural commodities to ensure that the tolerances for malathion are not exceeded. These tolerances are given in table IV-3 (see p. 30-32). Environmental components to be sampled will include water, air, soil, foliage, and biological organisms (USDA, 1989). Concentrations of malathion and its degradation products will be measured in sensitive areas, such as wetlands, wells, or streams adjacent to the treated premises.

Environmental monitoring of the diazinon soil treatment will consist of testing the strength of the diazinon used and testing soil, water, vegetation, and biological organisms to determine residual levels of diazinon.

VII. Conclusions

The oriental fruit fly is capable of causing serious economic damage to the agricultural industry of the United States. The Oriental Fruit Fly Regulatory Program is designed to prevent or reduce the spread of oriental fruit fly from areas of the conterminous United States where it may become introduced. Program alternatives of no action, quarantine-only, and quarantine and commodity certification were fully evaluated within this assessment. A range of control alternatives were comprehensively analyzed with respect to their potential environmental consequences; they included no action, quarantine-only, regulatory chemical controls (commodity fumigation with methyl bromide, diazinon soil treatment, and malathion bait spray), cold treatment, and vapor heat treatment. Recent regulatory programs for this pest have been based on a strategy of quarantine and commodity certification, using chemical controls, cold treatment, and vapor heat treatment. Based on our assessment, this strategy is considered efficacious and environmentally sound.

The confined and directed nature of the oriental fruit fly regulatory program greatly reduces potential for adverse environmental effects, especially when coupled with well-planned program safeguards or mitigative procedures. Program data, research, and careful evaluation indicate that all potential environmental effects have been identified. It is concluded that there will be no significant primary or secondary effects, negligible long term effects, and no significant unavoidable effects on the environment, expected as a consequence of the program. Cumulative effects also were considered, and the carefully coordinated use of chemical and other control methods in this program will not have an adverse effect on the environment.

Program mitigative measures will protect human beings and the quality of the human environment by: (1) ensuring that humans will not be exposed unnecessarily to program pesticides, (2) containing pesticides during mixing, loading, and storage, (3) utilizing appropriate control alternatives to protect sensitive areas, and (4) observing applicable laws and regulations pertaining to pesticide usage. Wildlife and species of concern will be protected from significant environmental risks by program design, the directed nature of program treatments, and specific mitigative measures. No significant adverse impacts are foreseen for the beneficial insect complex or for honey bees foraging in the vicinity of program treatments.

In conclusion, an effectively managed regulatory program is necessary to prevent the spread of oriental fruit fly and its possible establishment in areas of the conterminous United States where there is suitable habitat. APHIS has analyzed fully the potential consequences of its Oriental Fruit Fly Regulatory Program and concludes that the program will have beneficial effects on the agricultural economy and production of the United States, with no significant adverse effect on the quality of the human environment.

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Appendix A

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Appendix A. References

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